Program Executive Office
Cruise Missiles
and Unmanned Aerial Vehicles

Tactical Control System
for
Unmanned Aerial Vehicles

Mission Planner Industry Brief

21 April 1997

Mission Planner Industry Brief Agenda

0900-0930	Welcome / TCS Program Plan and Vision	Steve Parker or Lisa Coluzzi
0930-0945	TCS Overview	Steve Daniel
0945-1005	Software Architecture	Bill Sullivan
1005-1020	BREAK	
1020-1045	Questions and Answers	
1045-1115	Mission Planner Requirements	Roger Gray
1115-1135	BAA Process / Evaluation Criteria	Dori Sewell
1135-????	Questions and Answers	

TACTICAL CONTROL SYSTEM

OVERVIEW

TCS OVERVIEW

- PROGRAM OVERVIEW
- ACQUISITION STRATEGY
- STATUS & SCHEDULE

TCS OVERVIEW

PROJECT OBJECTIVES

- Support mission planning, mission execution and data dissemination for the Tactical Unmanned Aerial Vehicle (TUAV) and the Medium Altitude Endurance (MAE) UAV systems with growth to support data collection from the High Altitude Endurance (HAE) UAV.
- Interoperability with select Command, control, communications, Computers & Intelligence (C4I) systems in compliance with ASD C3I Joint Technical Architecture.
- Simultaneous flight and payload control of at least two UAVs beyond line of sight using one TCS.
- Interoperability with the family of UAV systems across multiple levels of interaction.

TCS OVERVIEW

MISSION

- Provide a **scaleable** and **reconfigurable** control system for command, control, communications and data dissemination support for the family of UAVs

TCS OVERVIEW

SCALEABLE

Five Levels of Interaction with the UAV:

- Level 1- Receipt and dissemination of secondary imagery/data;
- Level 2 - Direct receipt of imagery/data and dissemination;
- Level 3 - Level 2 + Control of the UAV payload;
- Level 4 - Level 3 + Control of the UAV (less launch & recovery);
- Level 5 - Full control of the UAV from launch to recovery.

TCS OVERVIEW

RECONFIGURABLE

Capability Tailored to the User:

- Land-Based
- Sea-based
- Air-Based

TCS OVERVIEW

- Notional Land-based System

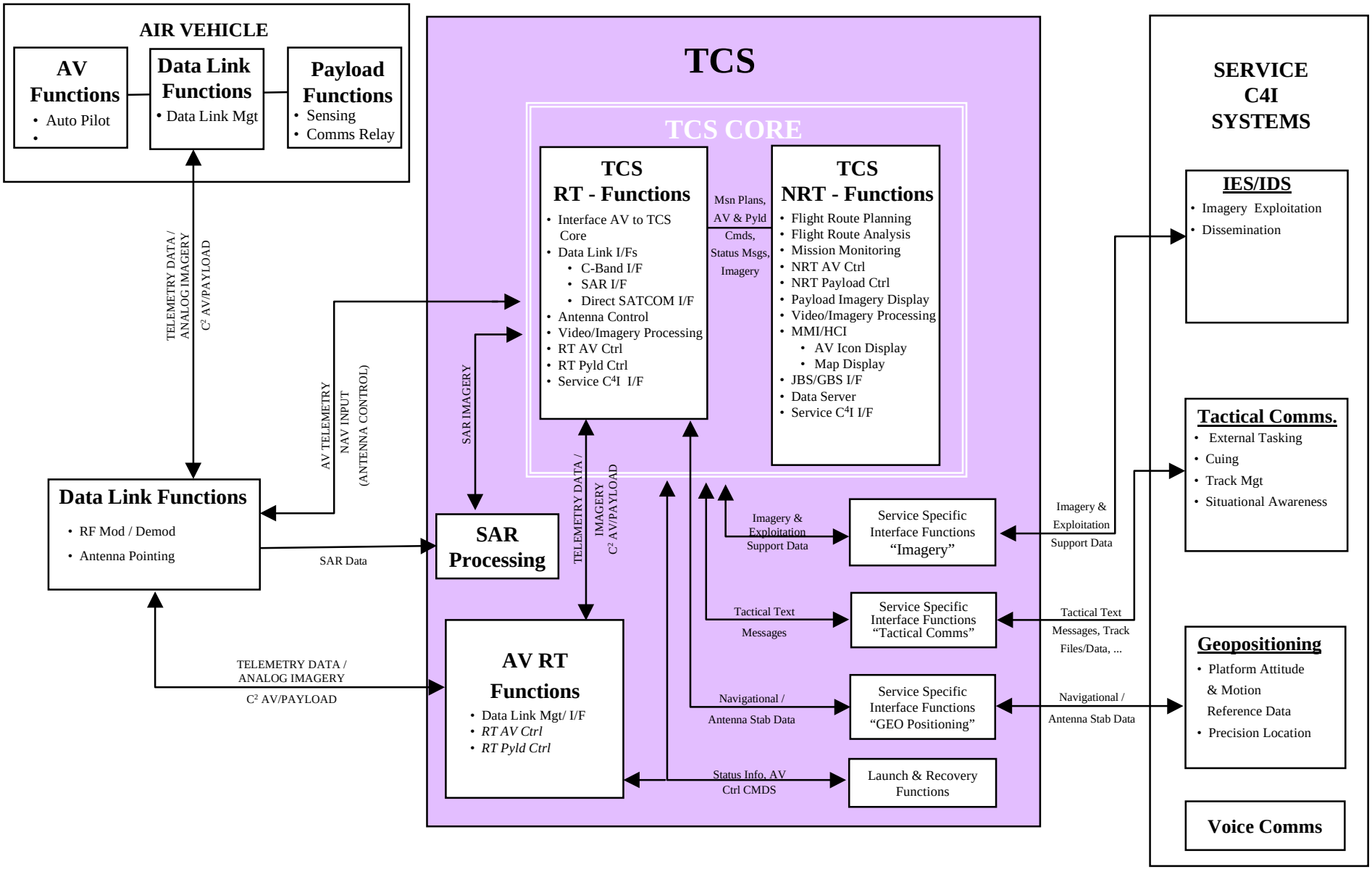
TCS OVERVIEW

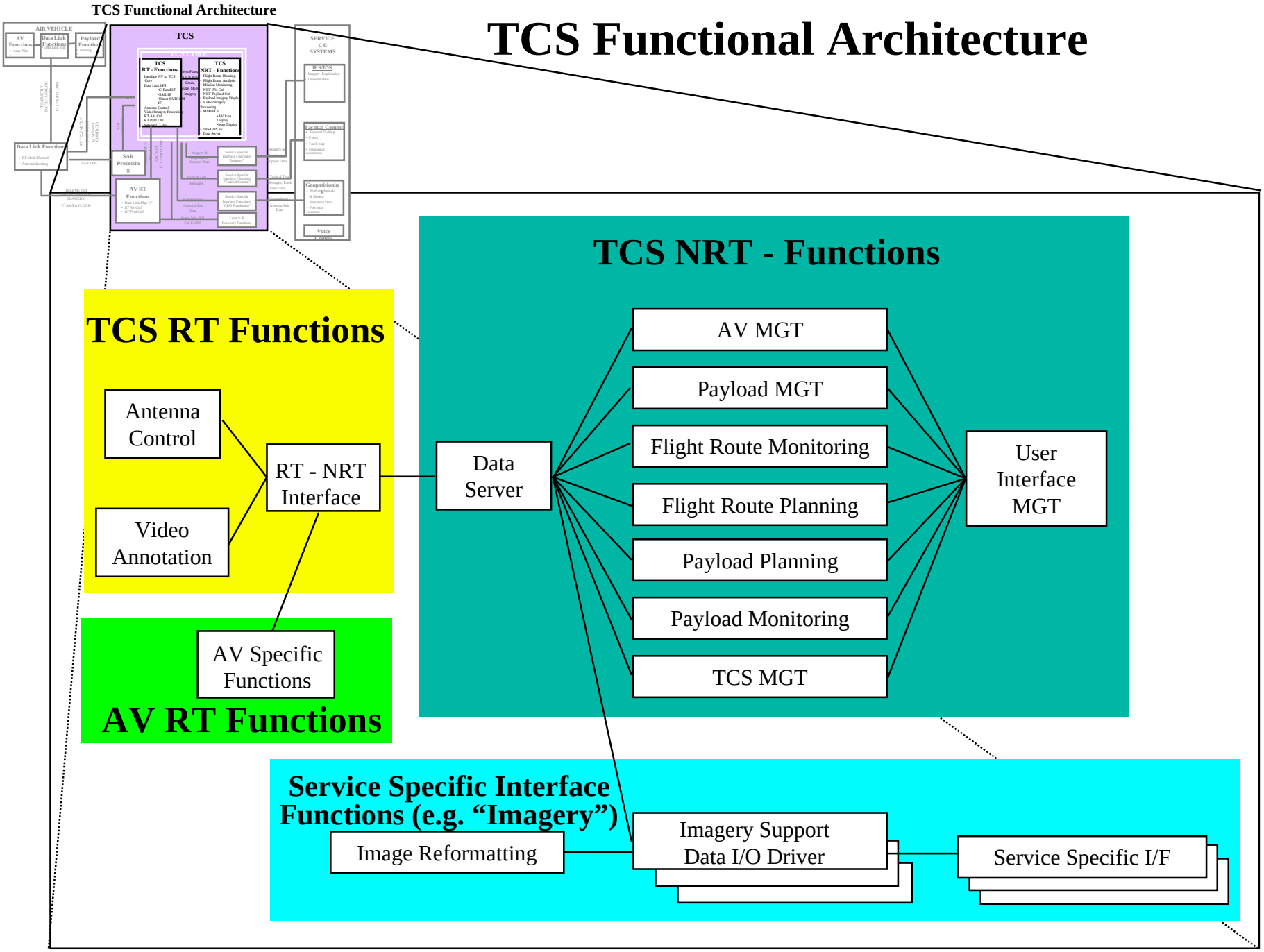
- Notional Sea-based System

TCS OVERVIEW

- Notional Airborne System

TCS Functional Architecture




TCS Functional Architecture
TCS Functional Architecture
TCS NRT - Functions
AV MGT
Payload MGT
Flight Route Monitoring
Flight Route Planning
Payload Planning
Payload Monitoring
TCS MGT
Data Server
User Interface MGT
TCS RT Functions
Antenna Control
Video Annotation
RT - NRT Interface
AV Specific Functions
AV RT Functions
Service Specific Interface Functions (e.g. “Imagery”)
Image Reformatting
Imagery Support Data I/O Driver
Service Specific I/F

TCS OVERVIEW

ACQUISITION STRATEGY

Three Phased Approach:

- Phase I - Program Definition and Risk Reduction
- Phase II - Engineering & Manufacturing Development (includes LRIP)
- Phase III - Production, Deployment and Operational Support

TCS OVERVIEW

PHASE I OBJECTIVES

- Define, prototype and demonstrate TCS functionality to reduce risk,
- document design & interfaces,
- develop a Joint CONOPS for the TCS that address the operational requirements of all services,
- develop ECPs, and
- provide three fieldable TCS prototypes.

TCS OVERVIEW

PHASE II OBJECTIVES

- Produce six LRIP systems,
- conduct DT/OT for all services,
- continue integration of the TCS with C4I systems,
- develop ECPs, and
- result in an Initial Operational Capability.

TCS OVERVIEW

PHASE III OBJECTIVES

- Produce & deploy 206 TCS nodes,
- develop ECPs,
- produce Final Operational Capability (fourth quarter of FY2000), and
- provide operational support.

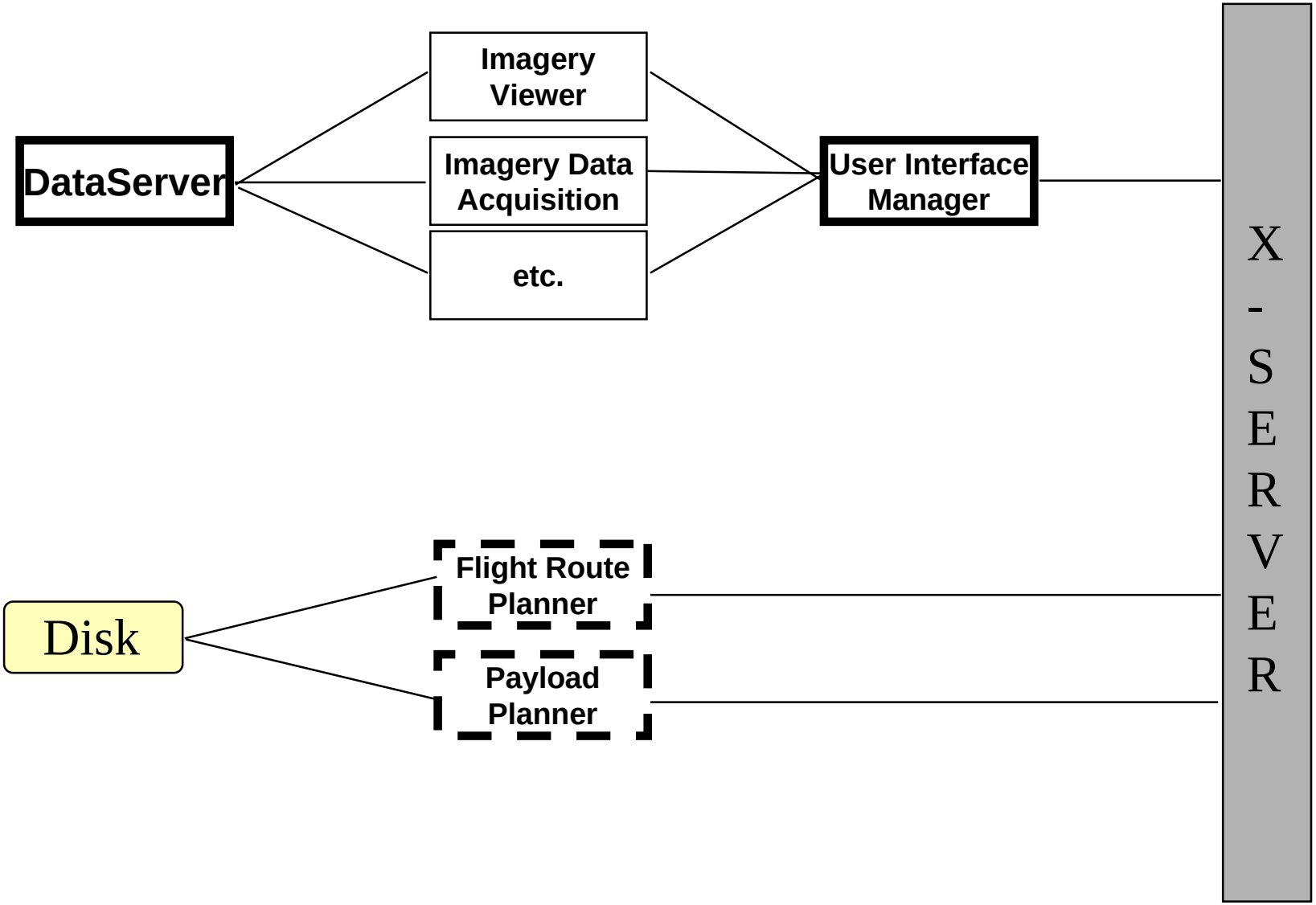
TCS OVERVIEW

SCHEDULE

ACTIVITY NAME	FY 96	FY 97	FY 98	FY 99	FY 00	FY 01
PHASE I PROGRAM DEFINITION & RISK REDUCTION						
PHASE II ENGINEERING, MANUFACTURING, DEVELOPMENT					IOC	
PHASE III PRODUCTION, DEPLOYMENT & OPERATIONAL SUPPORT						FOC

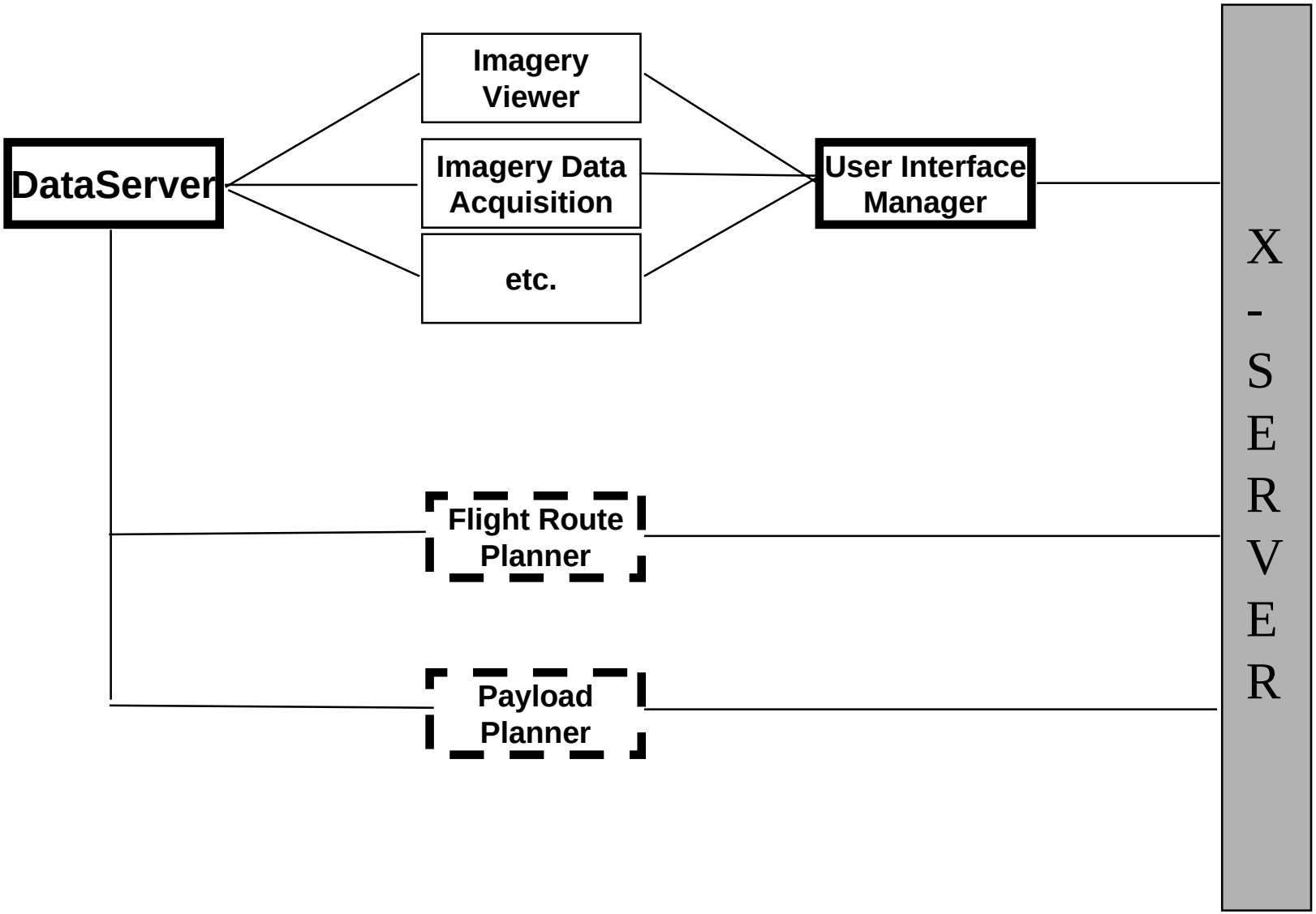
TCS Integration Proposal - Example

Same platform but not integrated



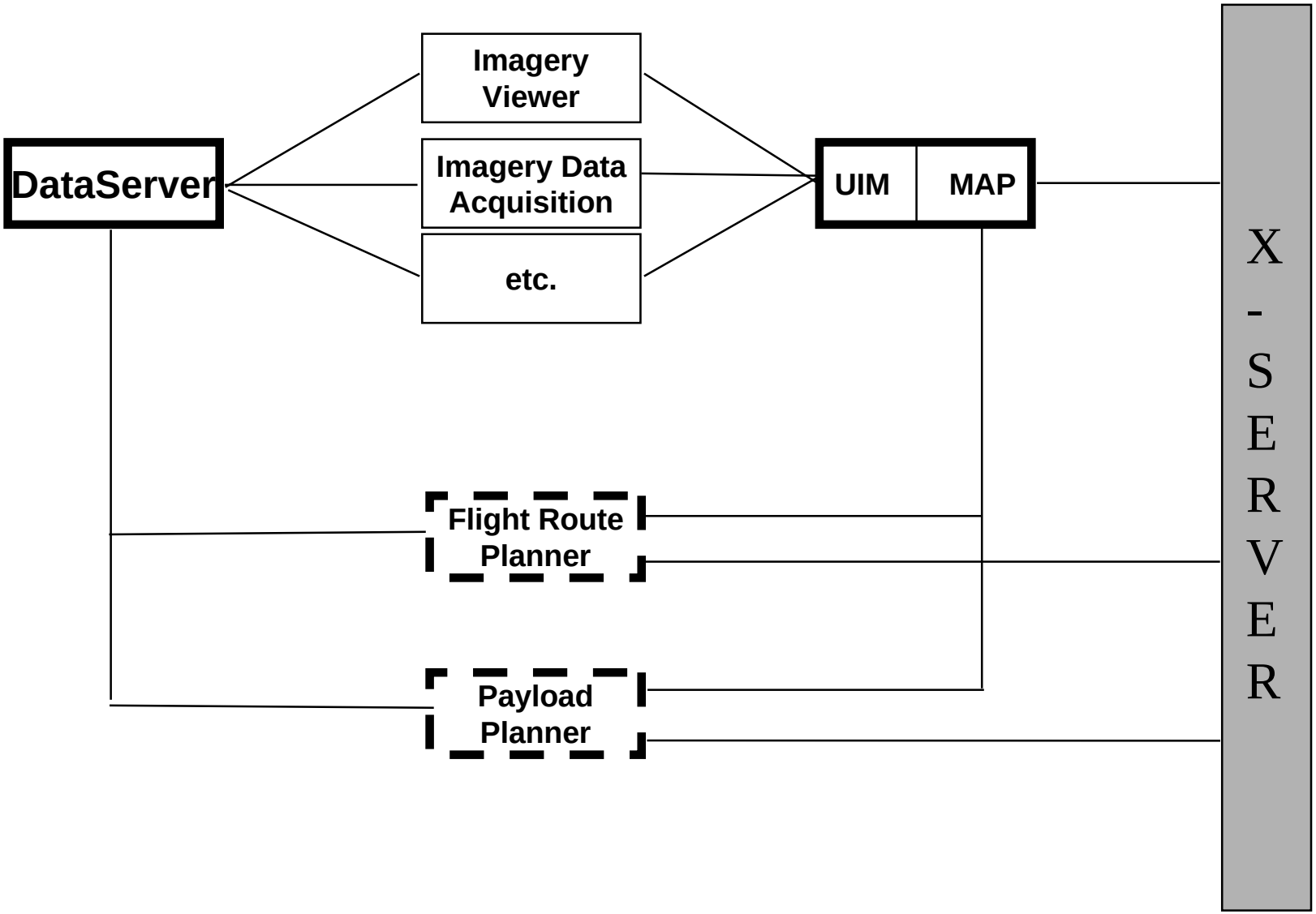
TCS Integration Proposal - Example

(1) Integrated for Data Exchange



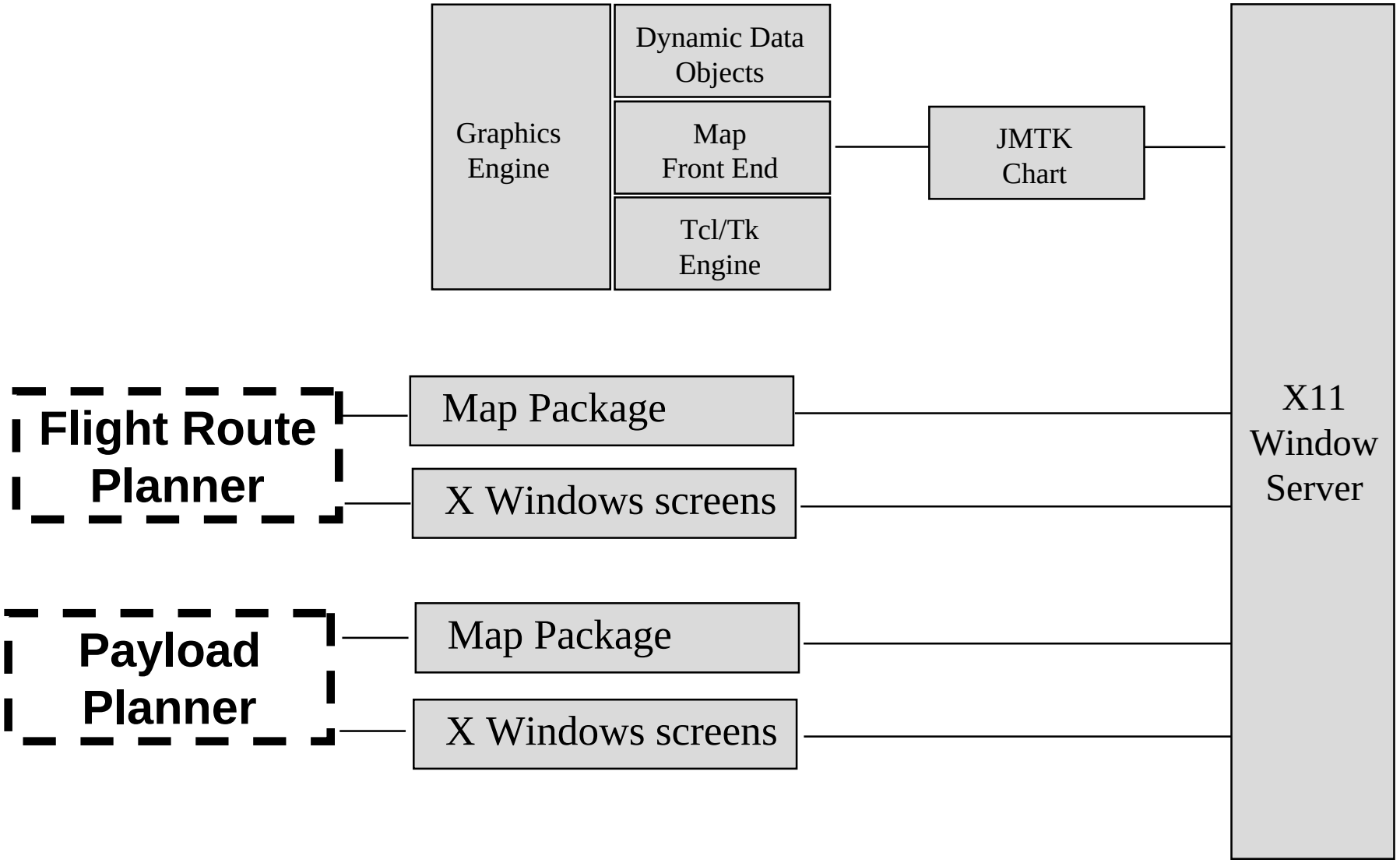
TCS Integration Proposal - Example

(2) Integrated to JMTK Map, Chart



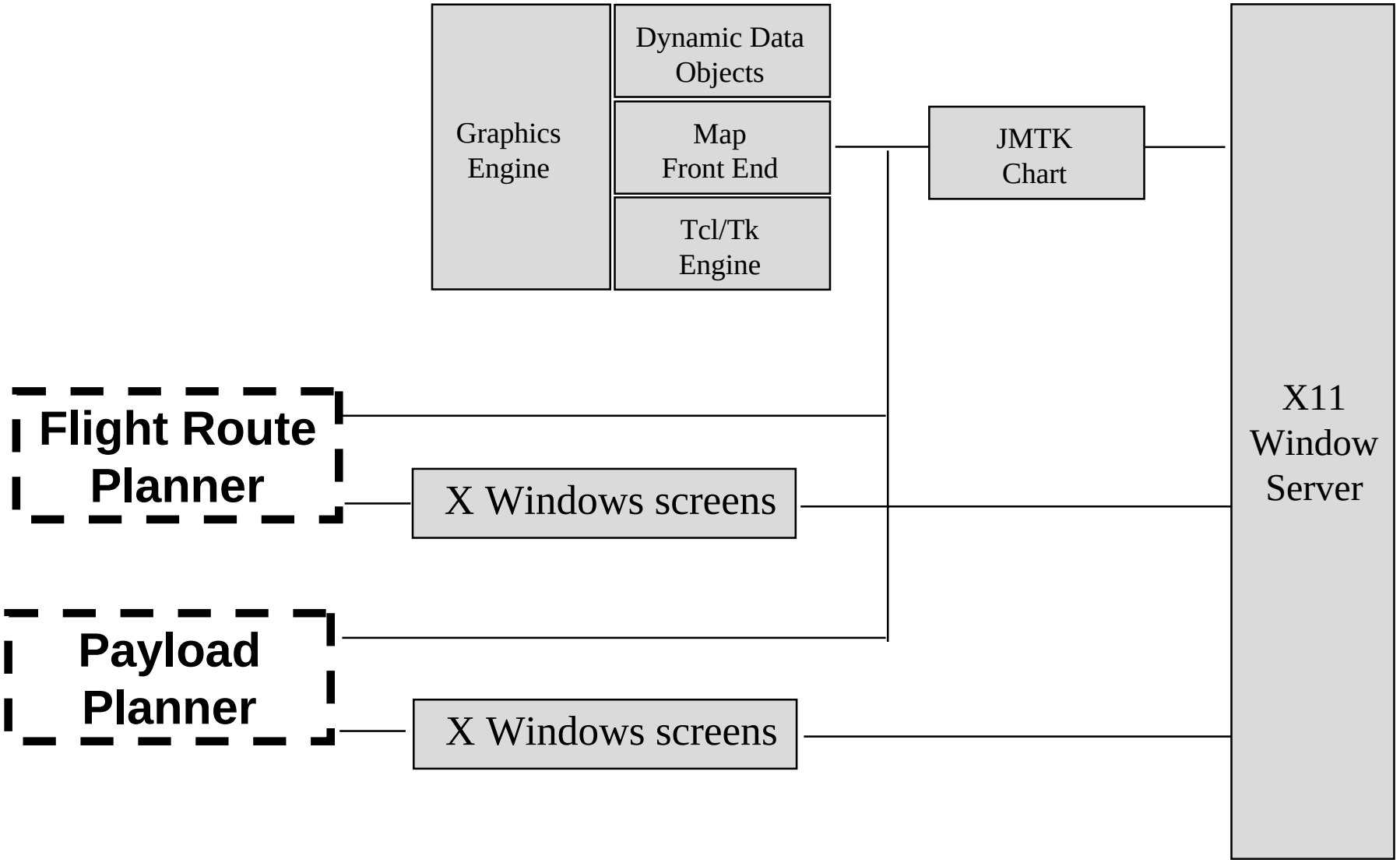
TCS Integration Proposal - Example

(1) Not Integrated to JMTK Map, Chart

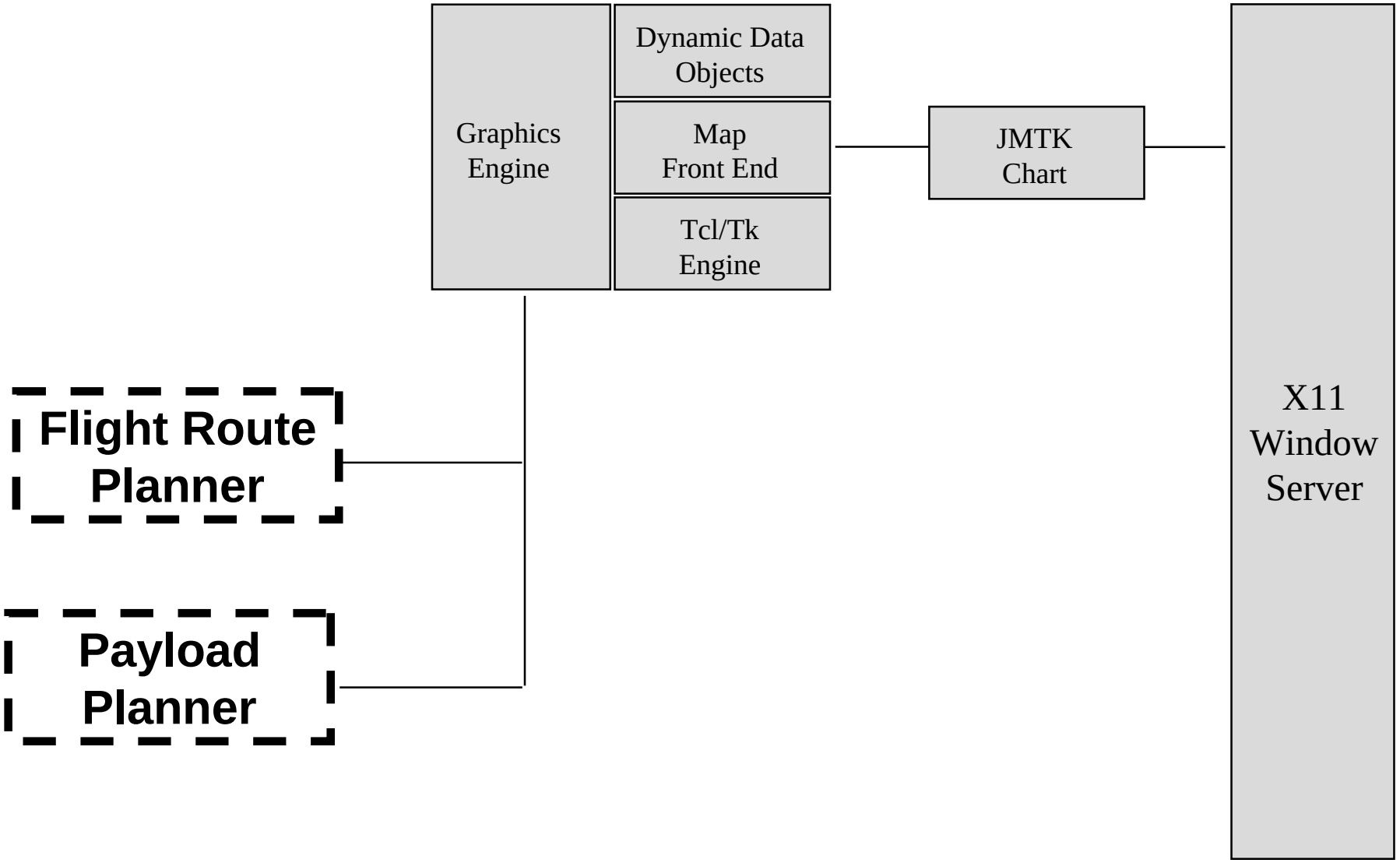


TCS Integration Proposal - Example

(2) Integrated to JMTK Map, Chart

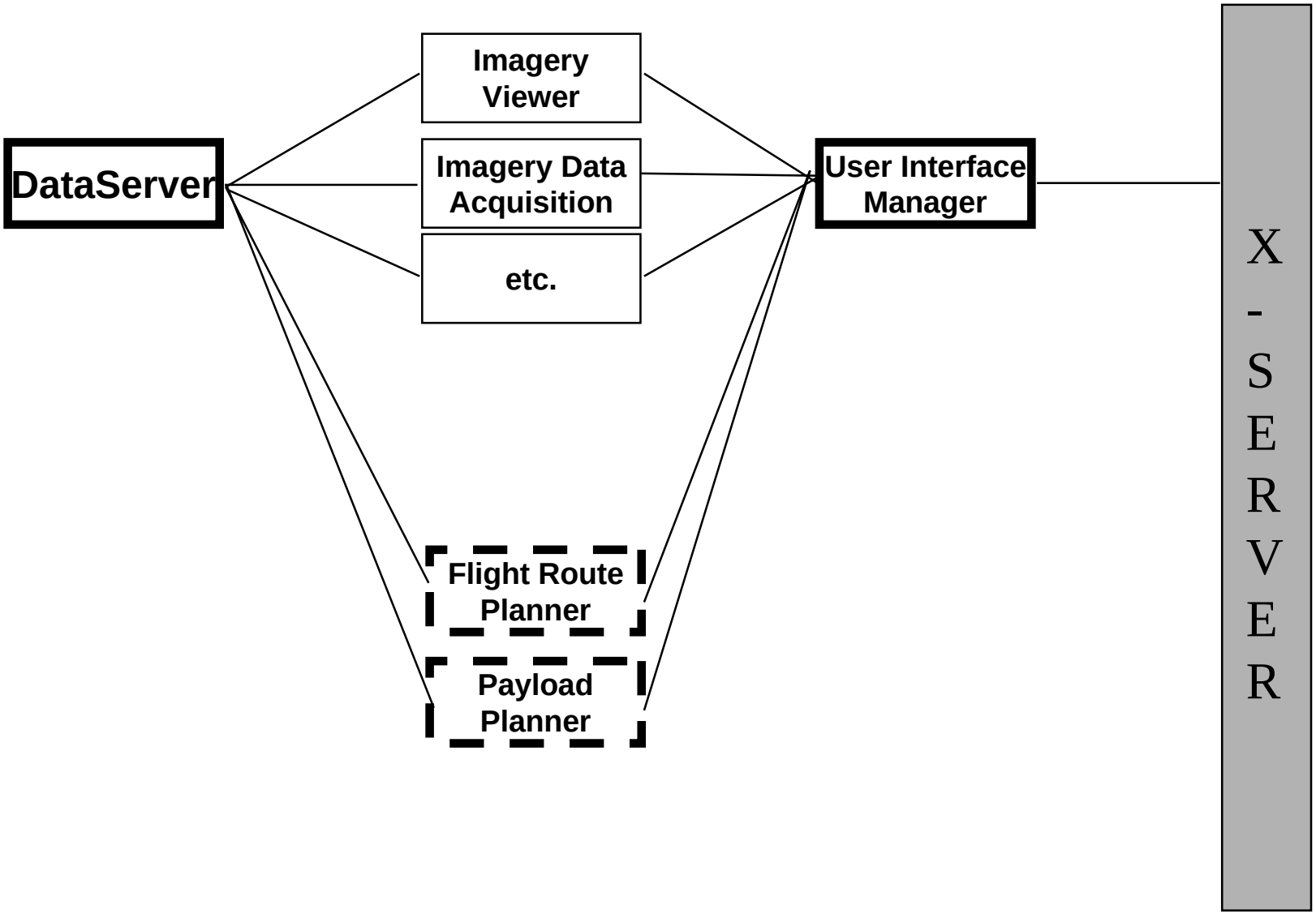


TCS Integration Proposal - Example
(Long Term) Integrated to TCS's UIM/GE



TCS Integration Proposal - Example

Complete integration into TCS



TCS
Software Design
Overview

April 1997

NAVAL SURFACE WARFARE CENTER
DAHLGREN DIVISION

TCS JORD Requirements

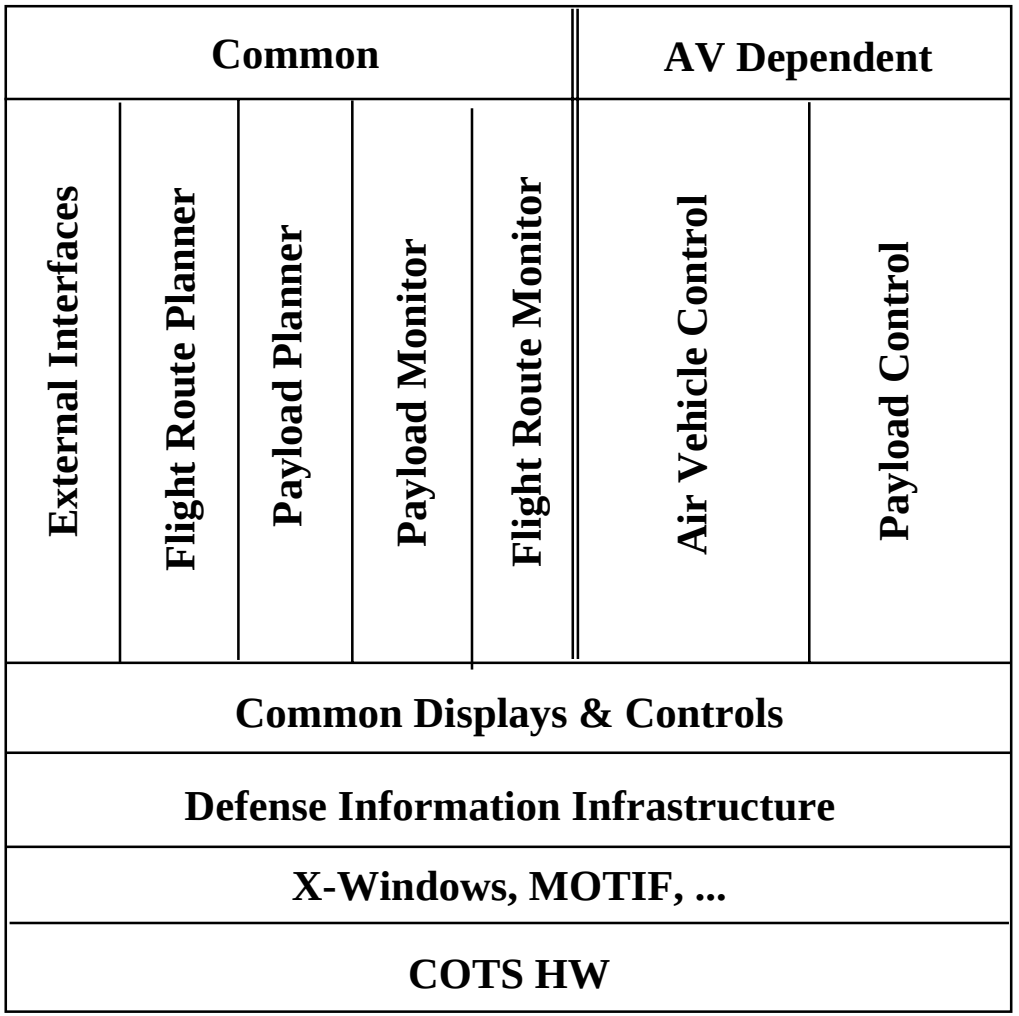
- Support existing Services computing resources
- Extensible and Upgradable
- Scalable across Commands echelons
- Distributive Processing
  - Single or Multiple CPUs
  - Single or Multiple Consoles
- Air Vehicle Independent
- Common HCI and Operator Controls

Existing Services Computing Resources

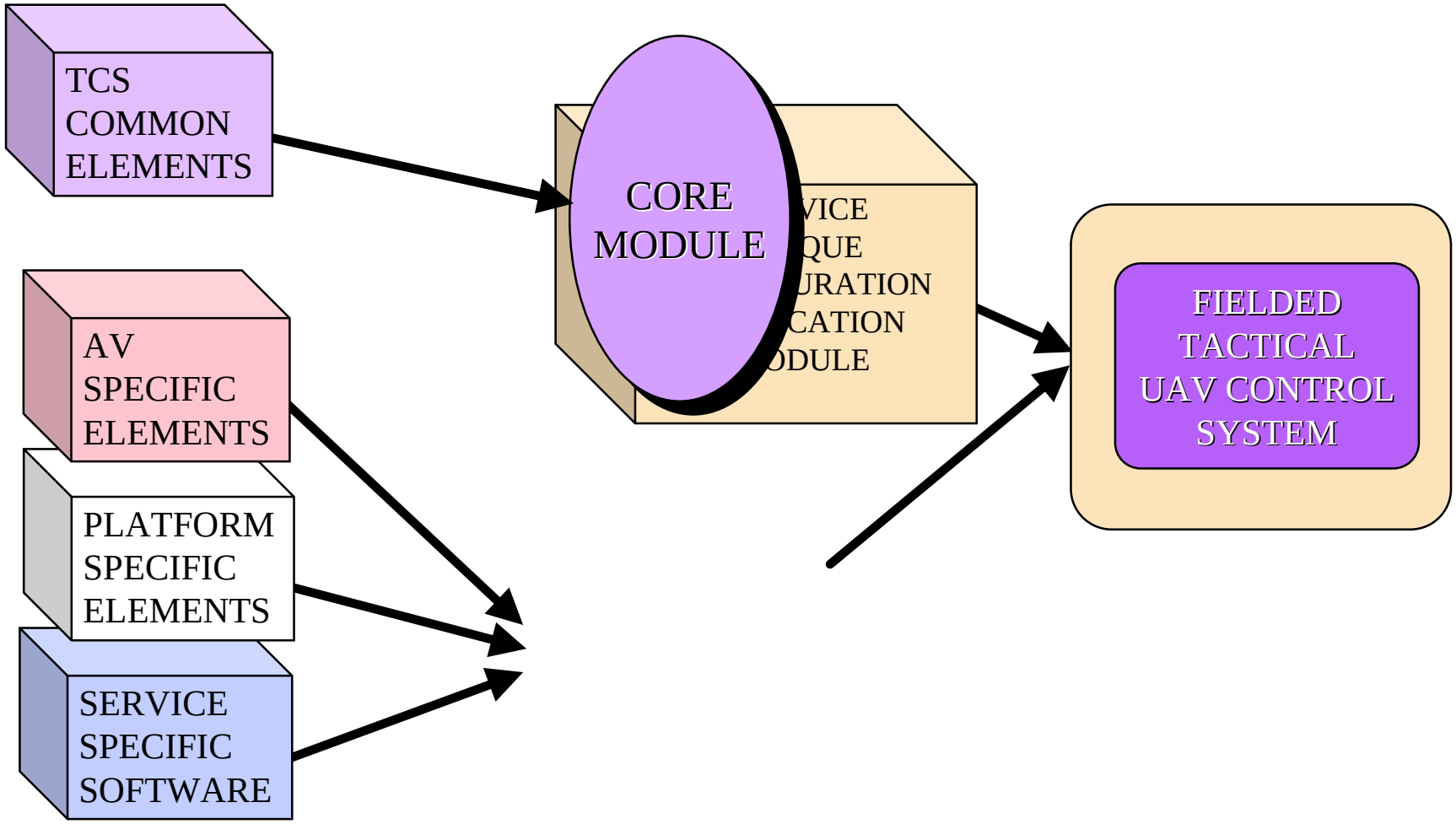
- Software shall be portable to all DOD supported platforms
- Shall be compatible with GCCS
  - Build to
    - *Defense Information Infrastructure (DII) COE*
      - http://spider.osfl.disa.mil/dii/index.html
- Interoperable with existing Service Systems
- TCS functional components shall be capable of being embedded into existing Service Systems as appropriate

DII COE

Software Applications (Functions)



Integration Support for Existing Systems



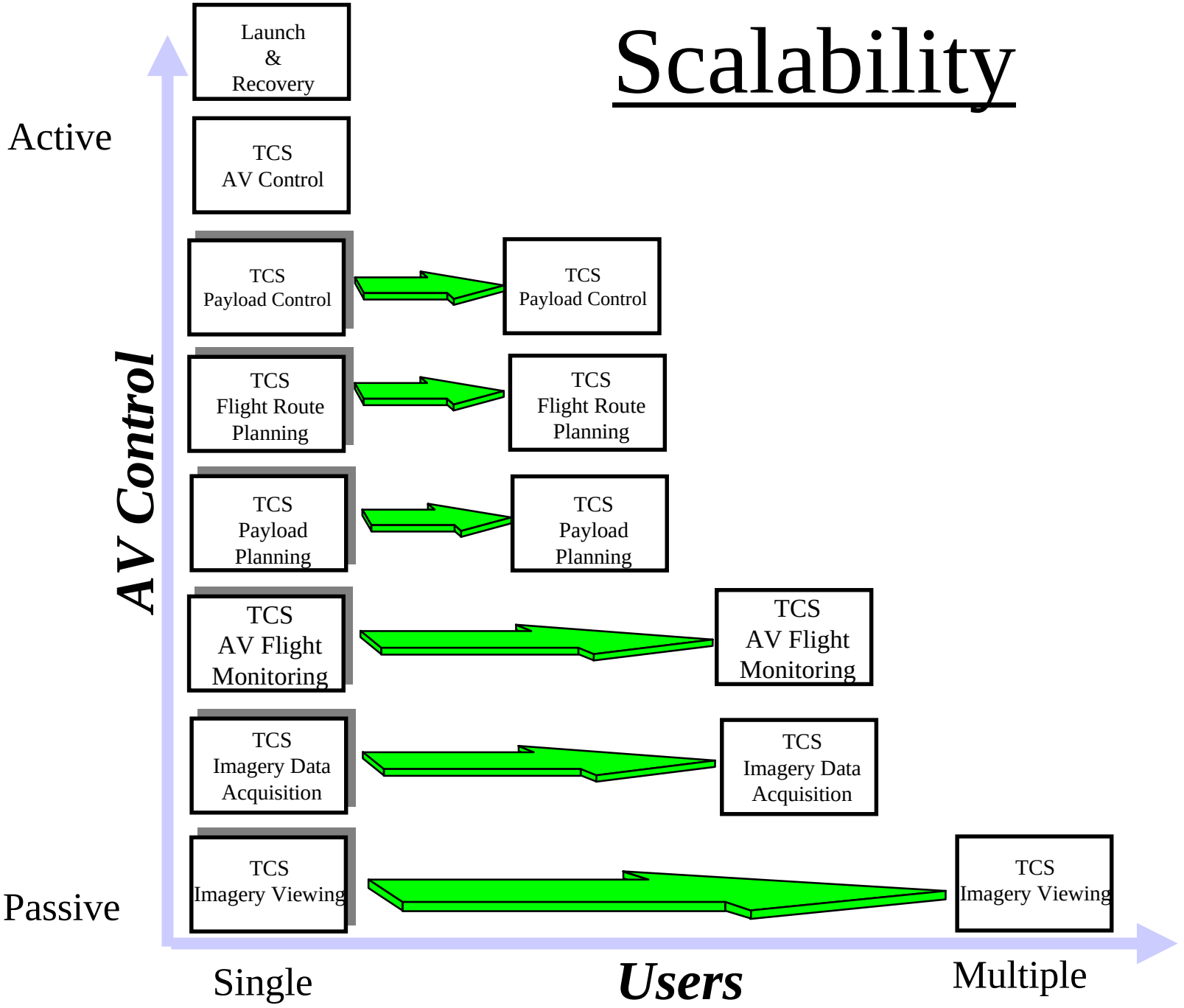
Extensible & Upgradable Requirements

- TCS must have the ability to add new functionality with out disrupting existing functionality
  - Reconfigurable
  - Dynamic linking techniques

Scalability Requirements

- Support all Command Echelons
- Provide users with only that functionality required for the job at hand

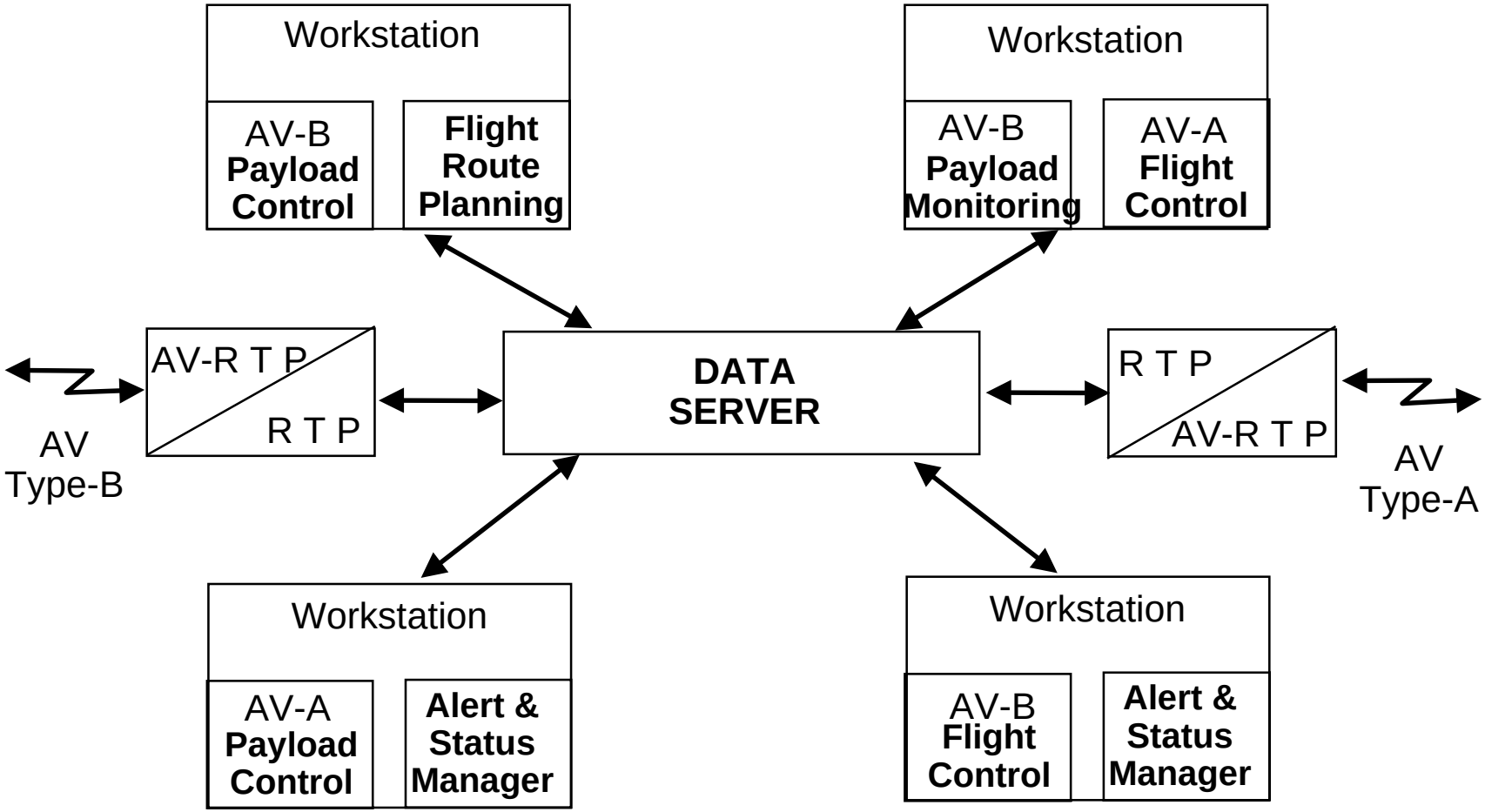
Scalability



Distributive Processing Requirements

- Distributed execution of TCS software across available CPU resources
- Distribute roles/consoles across available workstation resources

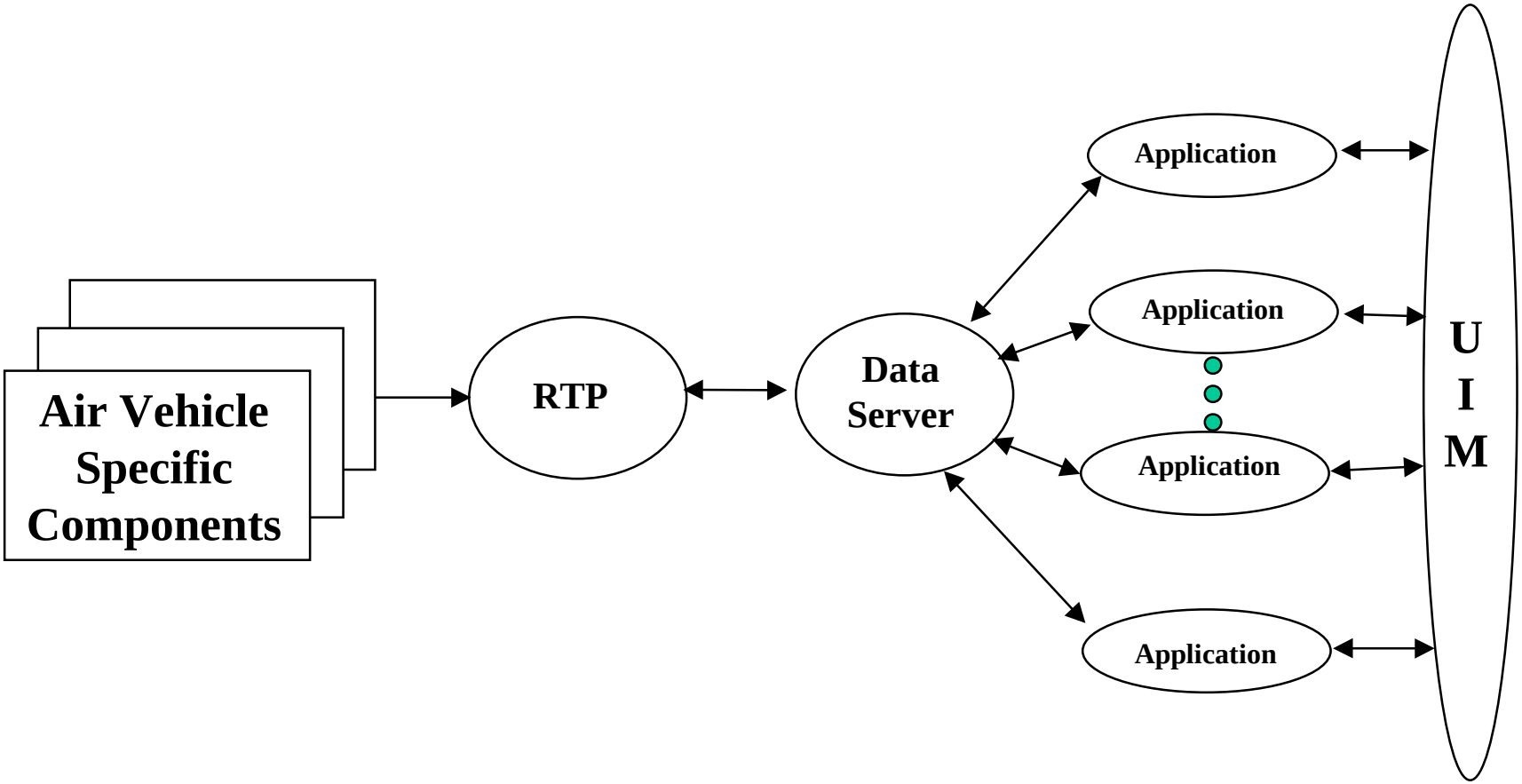
Distributive Processing Example



Air Vehicle Independent Requirements

- A common software core that will support multiple UAVs.
- Operational parameters will vary from mission to mission, AV to AV
- Common, standardized interface to AV specific components

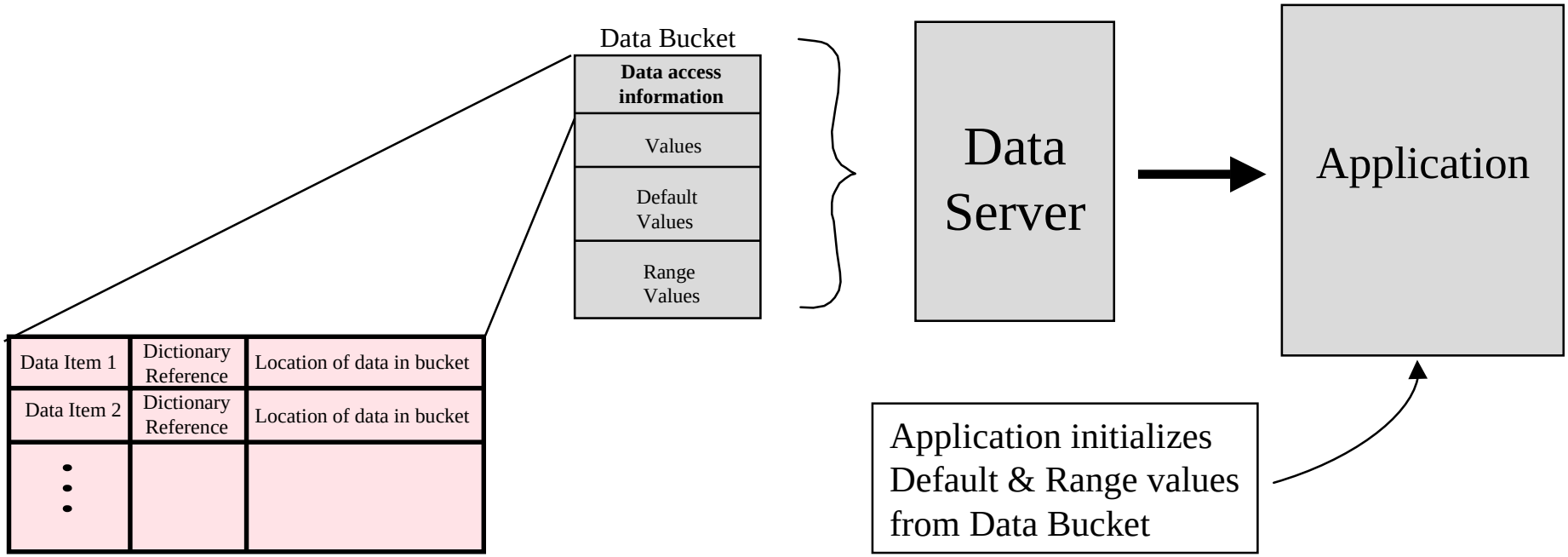
Air Vehicle Independent



Air Vehicle Independent

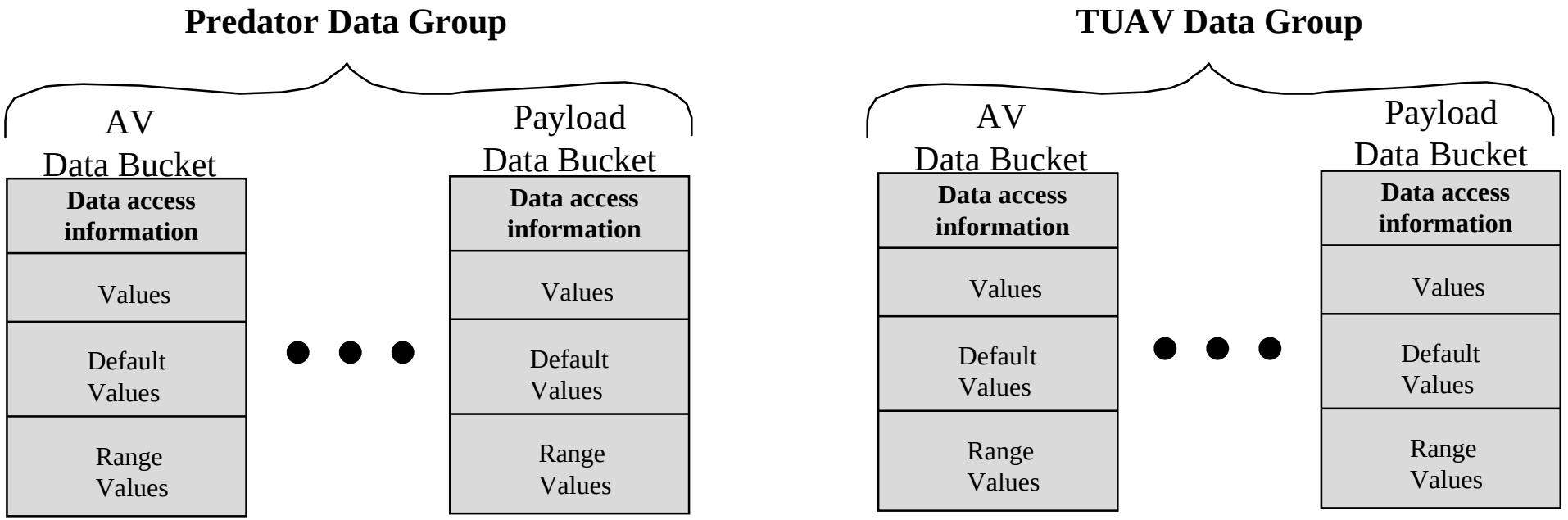
Data Buckets

- DataServer is used to propagate default and range values
  - Contents of buckets are defined by ***SCHEMAS***
- Access to data buckets is thru DataServer ***Client APIs***
- Data is retrieved using standardized ***Data Dictionary Names***



Air Vehicle Independent
Data Buckets

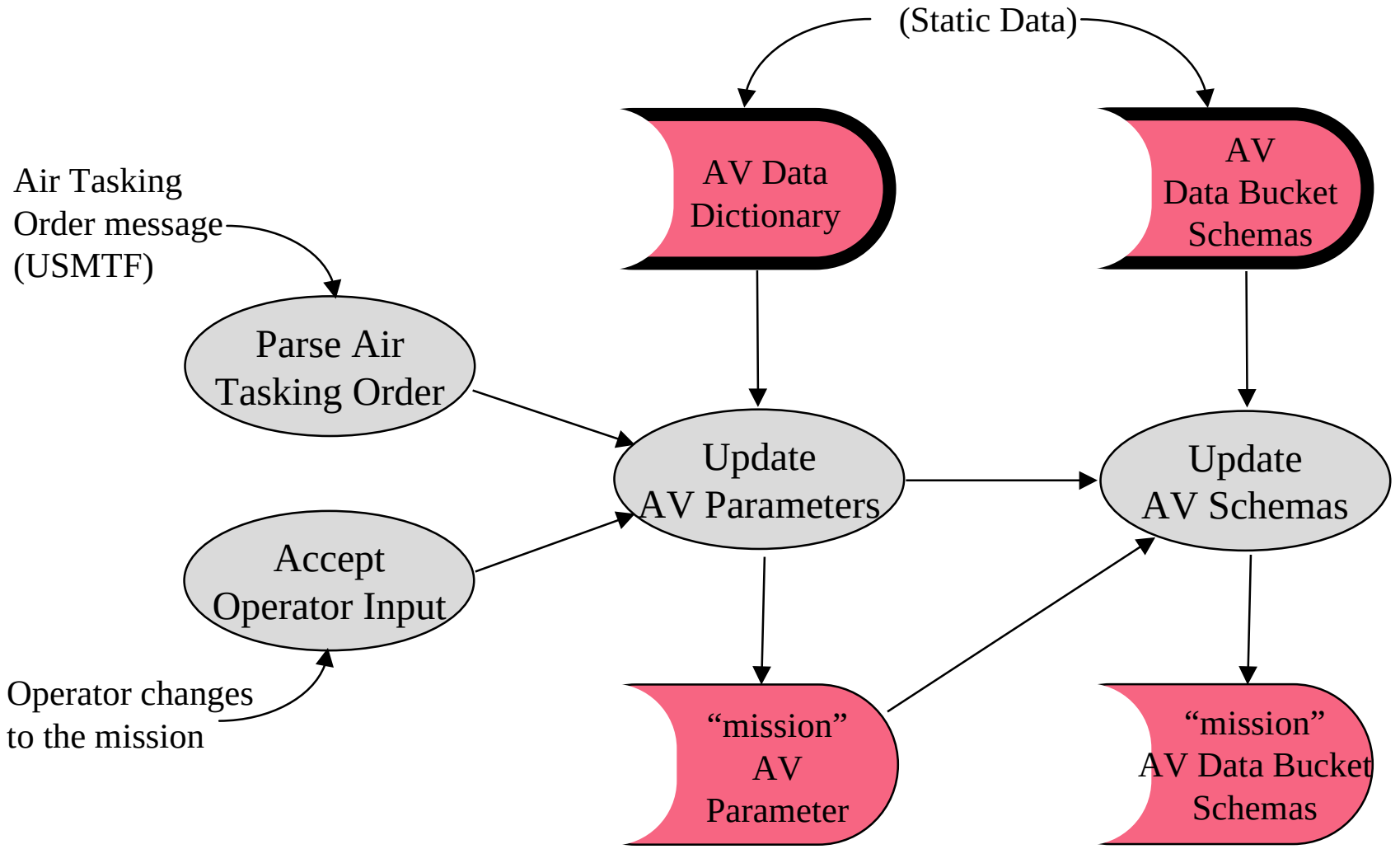
- (Continued)
- Data buckets must work from AV to AV
  - To keep buckets organized, buckets will be ***grouped by AV/Mission***



Operational Parameters

Schemas

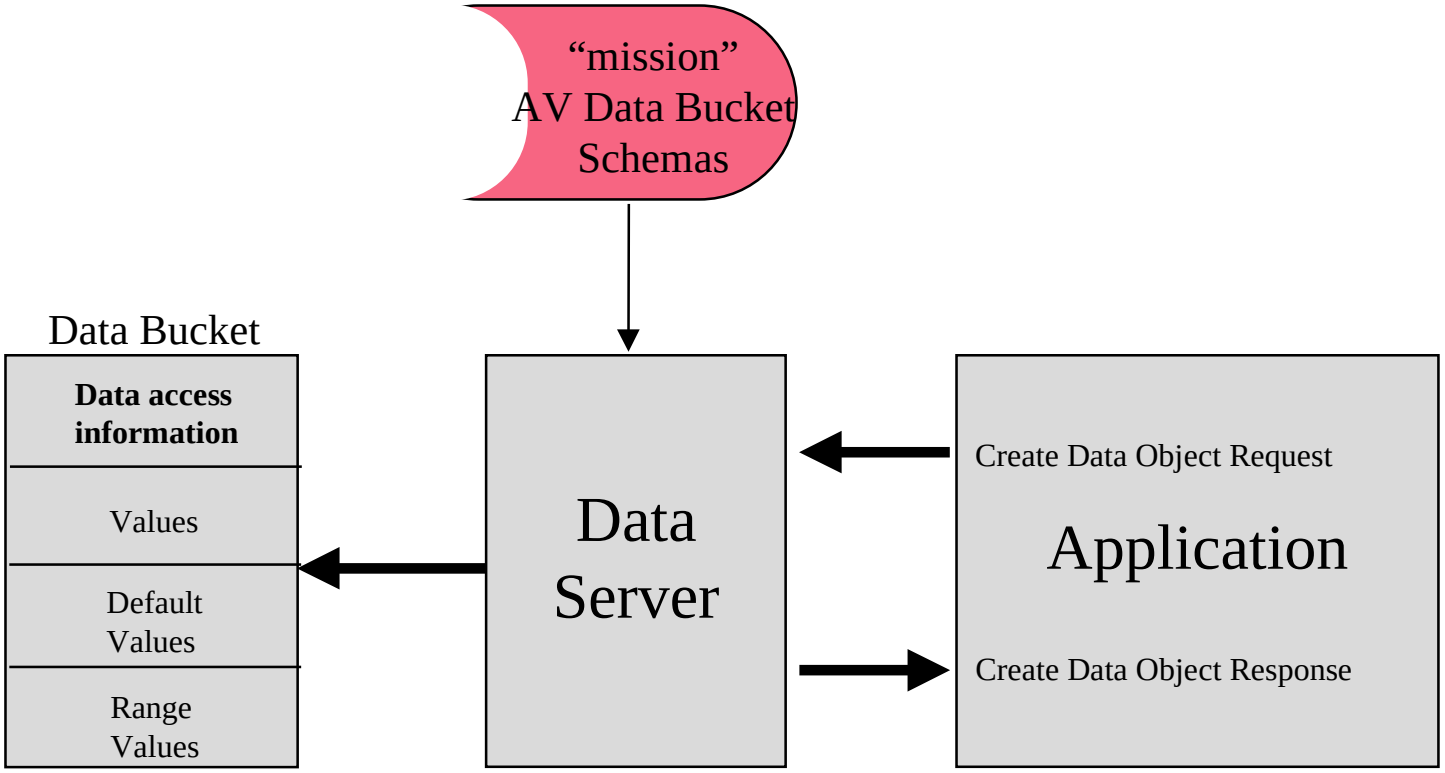
- Data Model:



Operational Parameters

Schemas

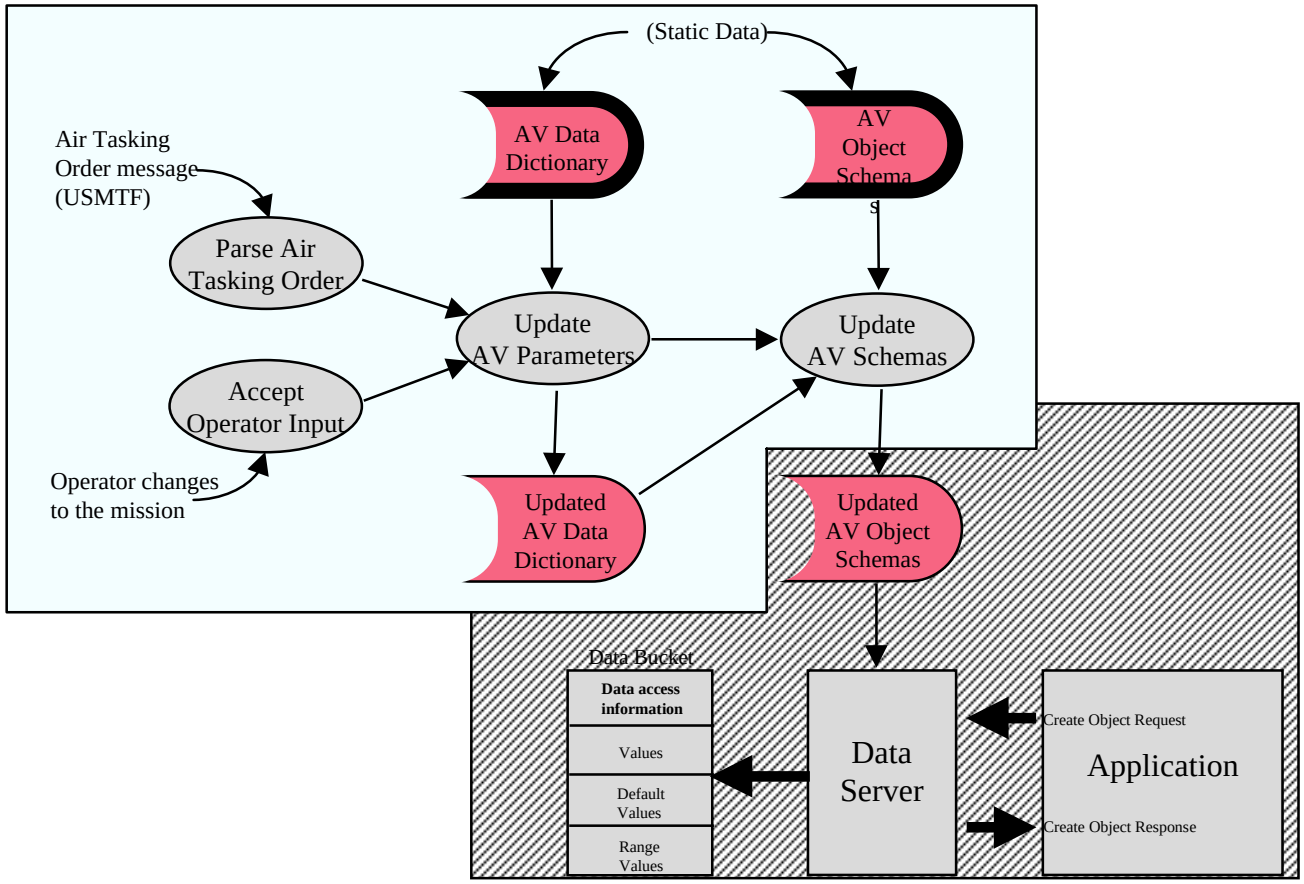
- Data Model: (Continued)



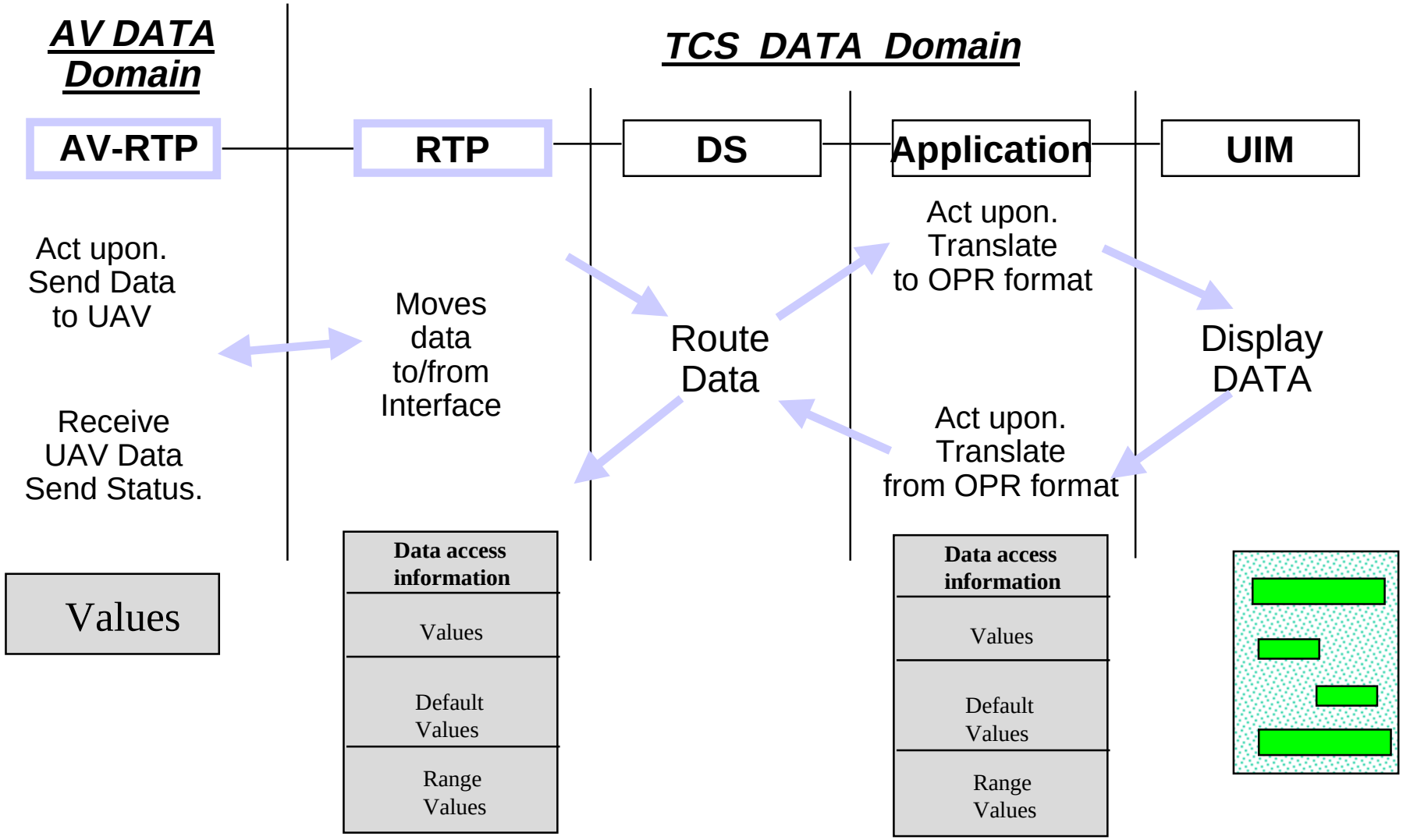
Operational Parameters

Schemas

- Data Dictionary defines all TCS data items, their specifications and their identifiers
- Schemas, which are based upon Data Dictionary, specifies the contents of a data bucket and the default and range values of the data within the bucket



AV Standard Interface

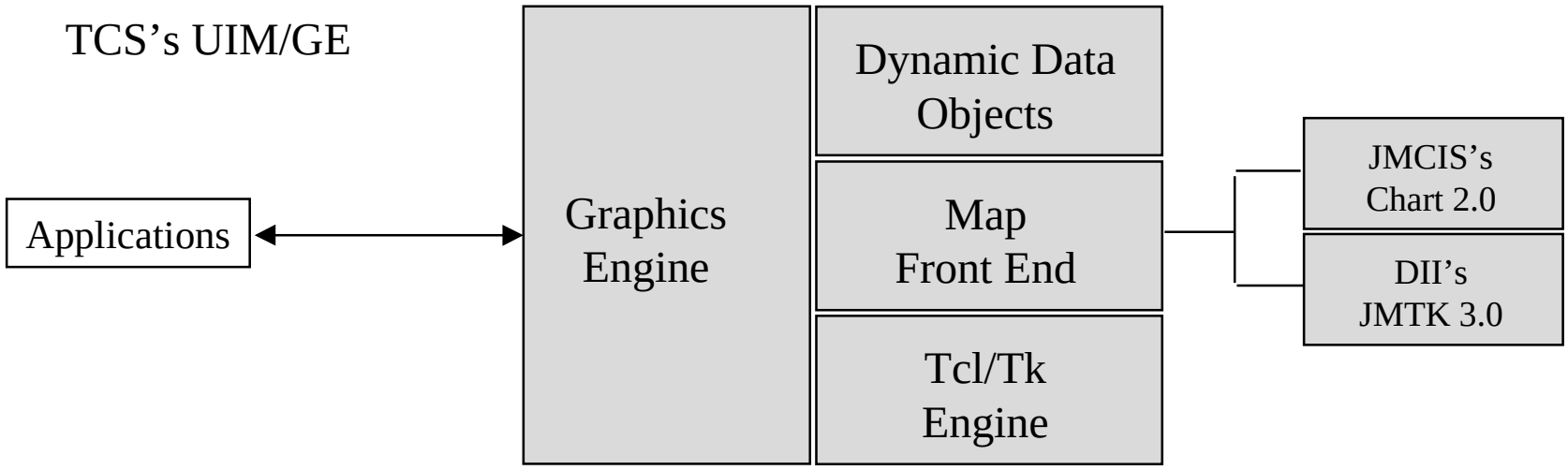


HCI Requirements

- HCI must remain consistent across UAVs
- HCI must support TCS customer base
  - Highly trained AV pilots
    - Launch & Recovery Operators; 20% to 30%
  - Trained TCS AV Operators
    - Mission Flight Operators; 70% to 80%
- HCI must be scalable
- HCI must support as many platforms as possible
- HCI must be compliant with DII

Common HCI

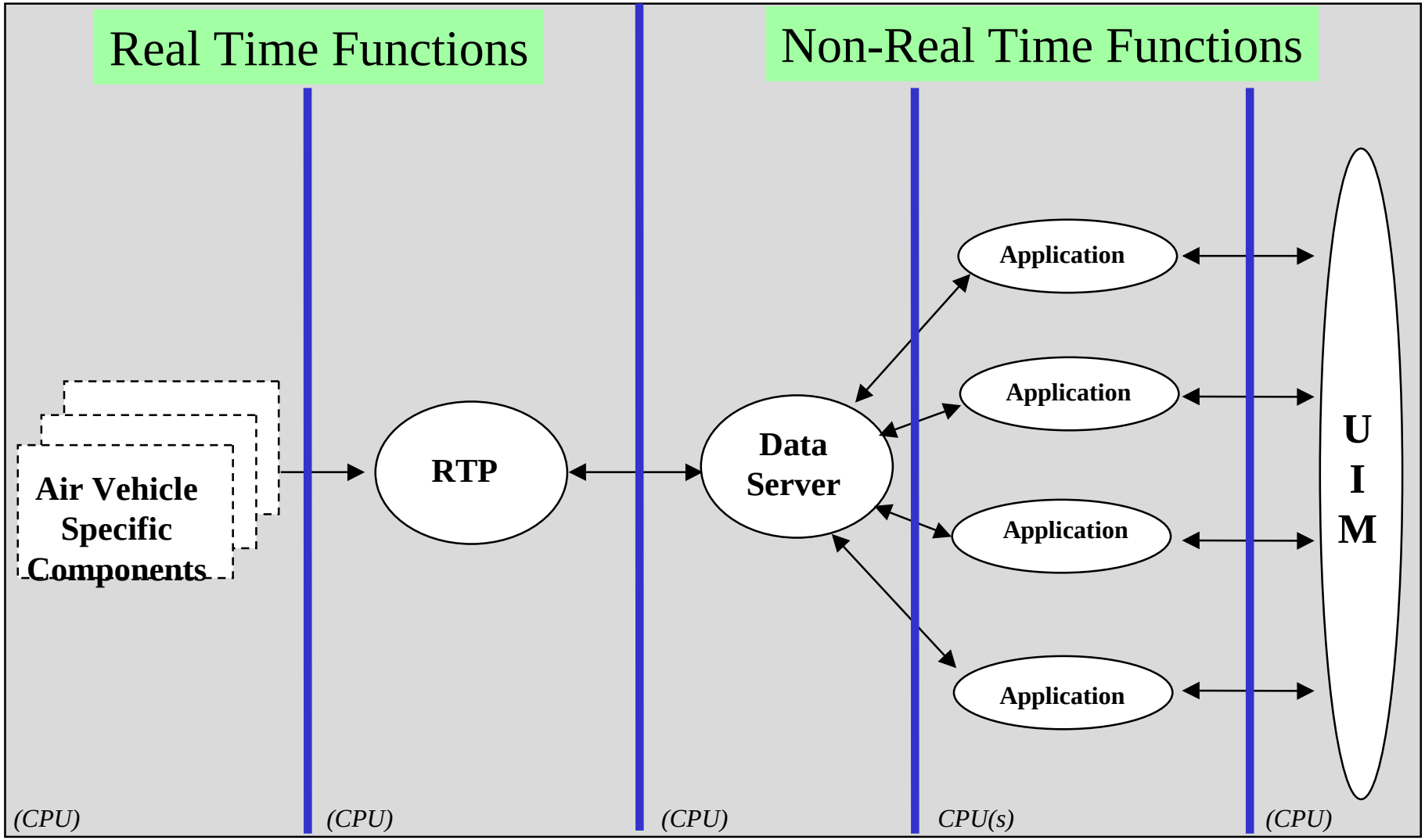
- Use “front ends” to accommodate packages that can be tailored to a specific environment
  - Map front end to accommodate different mapping packages
  - Tcl/Tk Engine for portability
    - Supports most versions of UNIX
    - Supports Microsoft’s Windows 3.1, 95, & NT (Future)



Summary
Architectural Goals

- NonReal Time
  - Provides a common framework by which AV modules are interconnected in order to provide “UAV” solutions
    - Allows for distributive computing environment as well as distributive operator control
    - Allows TCS functionality to be scaled to meet the needs of the targeted command echelon
- Real Time
  - Provides interface to AV’s real-time world and allows for any Service specific non-AV real-time requirements
- Provides a framework which allows TCS components to be interoperable with existing Service Command & Control systems
- Promotes reuse of common TCS components, *BUT* at same time allows for specific, unique components to meet AV’s requirements

TCS Architectural Frame Work



Framework Modules

- Real Time Processor
  - Provides interface to real-time events
- DataServer
  - Routes data through the system
  - Provides persistence storage & data logging
- User Interface Manager (UIM)
  - Graphics Engine (GE)
    - **Provides HCI screens as needed by Applications**
  - GE Data Driven Objects (GE_DDO)
    - **Provides dynamic screens such as flight gauges**
  - Map Front End

TCS
Functional Components

Functional Components

Passive

- Payload Imagery Viewer
  - RS-170 viewing via a video board
  - NITF image viewing
- Payload Imagery Data Acquisition
  - Payload Imagery Viewer **PLUS**
  - Payload downlink data and Image geo-position data
  - Capture of images and/or target data formulation
    - **NITF 2.0**
    - **Target information in textual format**
- AV Flight Monitoring
  - AV status data
  - Data Link status data

Functional Components

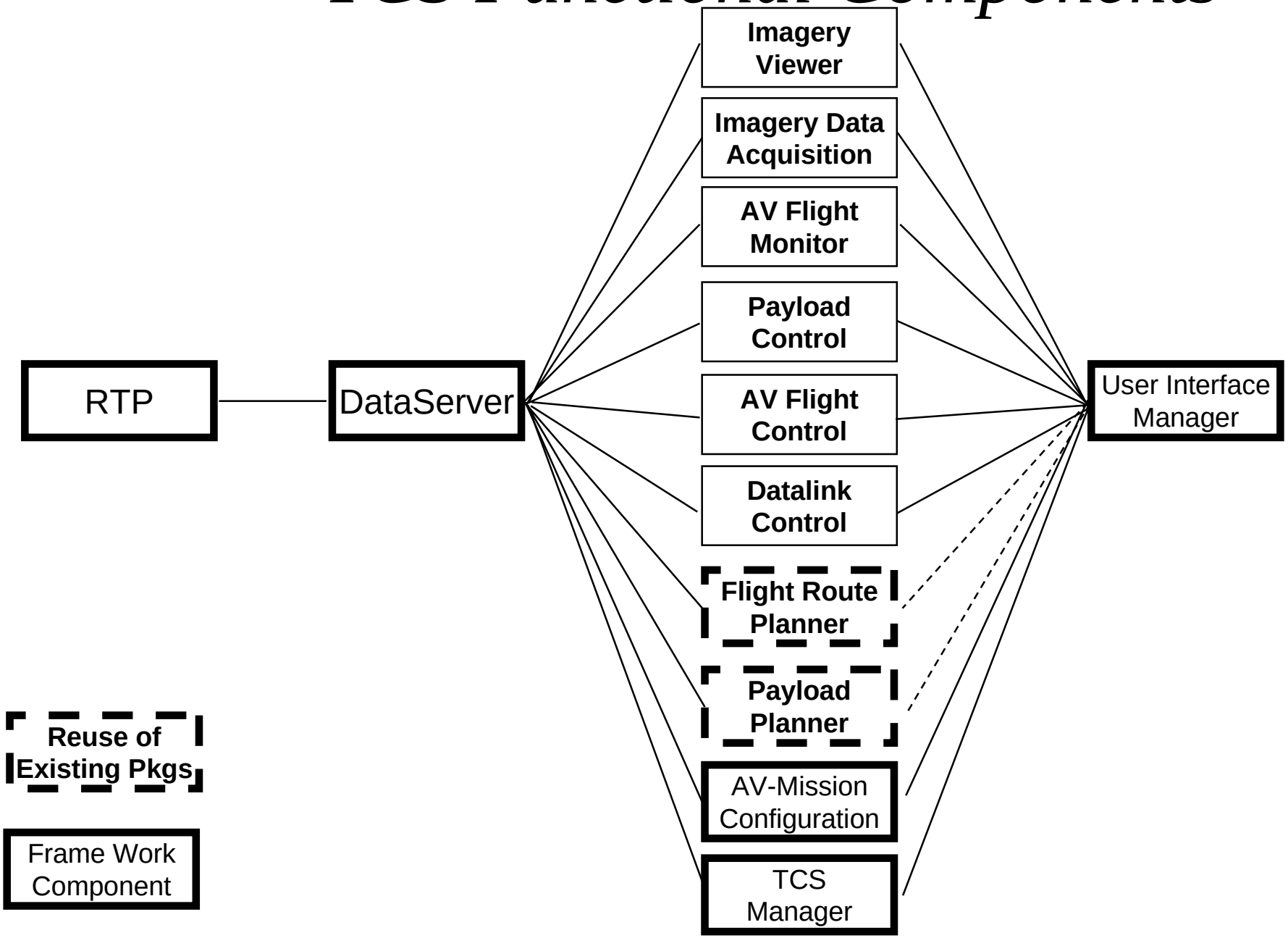
Active

- Payload Control
  - Payload Imagery Extraction **PLUS**
  - Operator commands for controlling a payload
- AV Flight Control
  - AV Monitoring **PLUS**
  - Route Plan data upload to AV
  - “Fly to Destination” commands
  - General AV commands for auxiliary systems such as
    - **Lights, IFF, etc**
  - Emergency Operation Commands
- DataLink Control
  - Operator commands for controlling the datalink

Functional Components
Independent

- Flight Route Planner
  - –Flight route construction
  - –Flight route analysis
    - **Requires knowledge of UAV performance characteristics**
- Payload Planner
  - –Payload actions along a flight route
    - **Requires knowledge of payload characteristics**

TCS Functional Components



TCS Software
Summary

- AV Independent
  - Define Standard Data Dictionary
  - Implement Data Buckets
  - Implement common/JII AV-RTP Interface
- Distributive Processing
  - Fundamental to design of architecture
    - **Distributive computing & Roles/Consoles**
- Extensible
  - Supported by Architecture
- Existing Services Computing Resources
  - DII COE
  - Implement Service Interfaces as Extensions
  - Software Integration process for Tactical Systems
- Common HCI

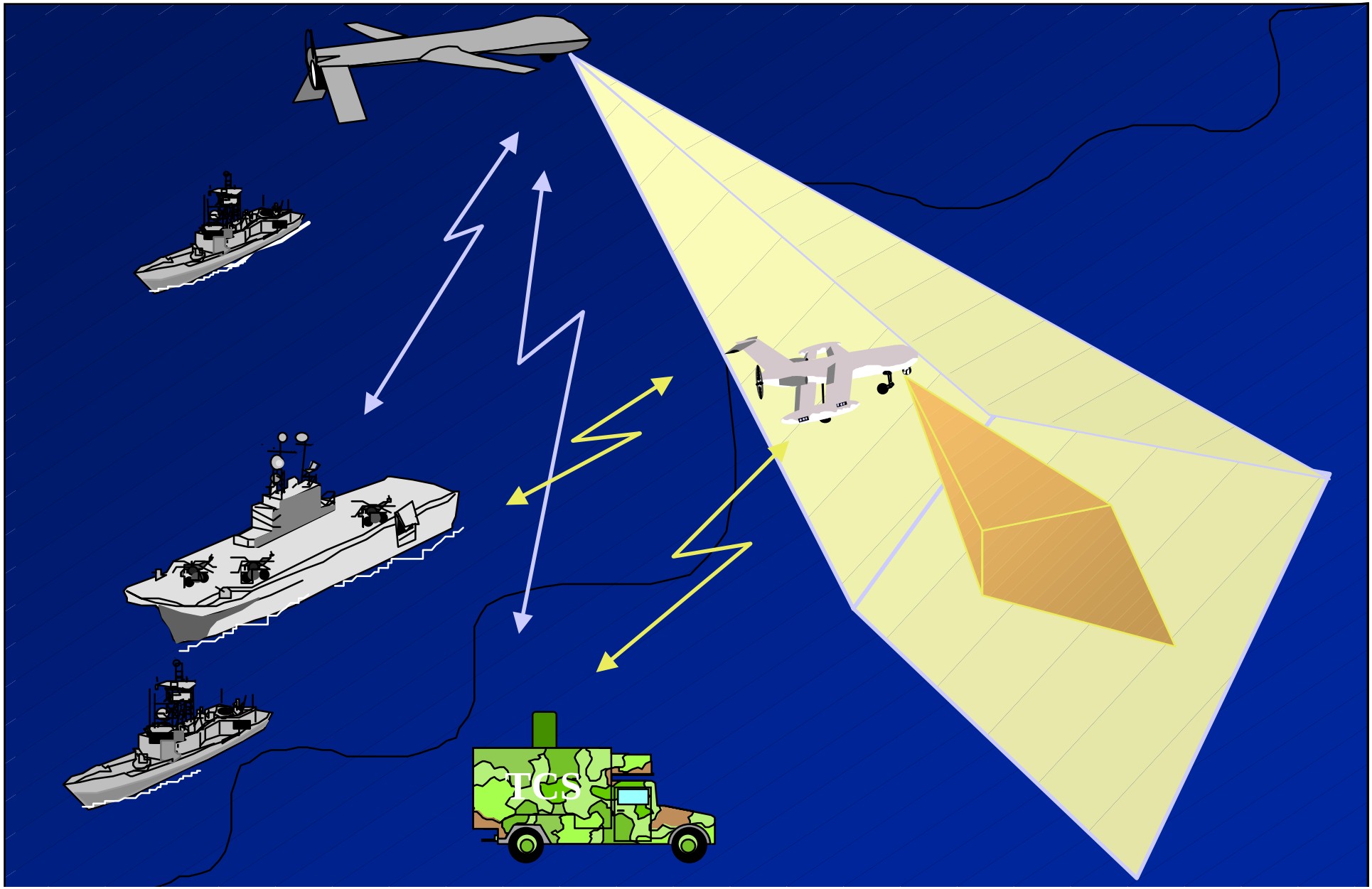
Mission Planner Requirements

Roger Gray
K63, NSWCDD
21April 1997

Overview

- Multi-UAV Control
- Minimum Criteria
- Route and Payload Planning
- Map Based Planning
- Data Entry
- Planning Aids
- Validation
- General Requirements

TCS Multi-UAV Control



Minimum Criteria

- Operational on
  - TAC-4 Hewlett Packard HP9000/J210 with 320 MB memory
  - CHS-II Sun Sparc 20 Model 152 MP with 256 MB memory (Solaris 2.5)
- Available for demo within two weeks of white paper submission
- Applicable to fixed wing aircraft
- Supports different fixed wing aircraft by changing data
- Plans Electro-Optical/Infrared (EO/IR) mission

Route and Payload Planning

- AV route planning
  - (MC) Works with fixed wing aircraft (e.g., Predator, Outrider)
  - (MC) Supports different fixed wing aircraft via data change
  - (H) Open architecture to support other AV types
- (H) Emergency (Return Home) planning
  - Same as AV route planning, but visually distinct
- Payload planning
  - (MC) Electro-Optical/ Infrared (EO/IR)
  - (H) Open architecture to support other payloads
  - (M) Synthetic Aperture Radar (SAR)
- (M) Communication Planning

Route and Payload Planning (Cont.)

- (H) Payload and route planning are separable
  - Integrated payload and route planning
  - Separate payload and route planning
- (H) Plan route or payload during all phases of operation
  - Prior to flight
  - While concurrently flying a mission (dynamic retasking)

Map Based Planning

- (H)JMTK (DII) used for mapping functionality
  - Use compact disk NIMA data (DTED, DFAD, ADRG, vector format, CADRG)
  - Pan/scroll, zoom, cursor coordinate display, etc.
- Map based plan creation/display
  - (H) Waypoint entry via point and click
  - (H) Waypoints and flight path graphically displayed

Data Entry

- Text entry
  - (H) Waypoint coordinates (in addition to point and click)
  - (H) Route and payload data
  - (H) Mission data
  - (H) AV and payload data
  - (H) Environmental data
- (M) Multiple units (Standard English, Metric)
- (M) Multiple coordinate systems
  - Lat/long
  - Universal Transverse Mercator (UTM)
  - Military Grid Reference System (MGRS)

Planning Aids

- Overlays
  - (H) Payload swath
  - (M) Datalink coverage
- (H) Mission data computation
  - Time
  - Distance
  - Fuel
- (M) Flight profile vs. terrain

Validation

- Checks
  - (H) Flight safety
  - (H) Datalink (Line-of-Sight)
  - (M) Launch weight and balance
  - (M) Plan achievability
- (H) Inform operator of failures
- (H) Operator can override failures

General Requirements

- (H) DII compliant
- (H) Non-Proprietary route and payload planning software
- (H) Release to foreign nationals
- (M) Interoperable with force level mission planners
  - AFMSS
  - TAMPS
  - AMPS
- (M) Documentation available

TCS Mission Planner BAA Process & Evaluation Criteria

Dori Sewell

K63, NSWCDD

21 April 1997

Document Packet

- Mission Planner Specific Documents
  - Evaluation Plan
  - Integration Schedule
  - Criteria Document
- TCS General Documents
  - Operational Requirements Document
  - System/Subsystem Specification
  - Program Management Plan
  - Data Server Interface Design Document
  - Software Design Document

TCS Mission Planner BAA

- *Mission planner:* consists of route planner and payload planner segments
- Purpose: identify a route planner and payload planner that can be integrated into TCS to support a wide variety of UAVs and their payloads for Phase 1 TCS development

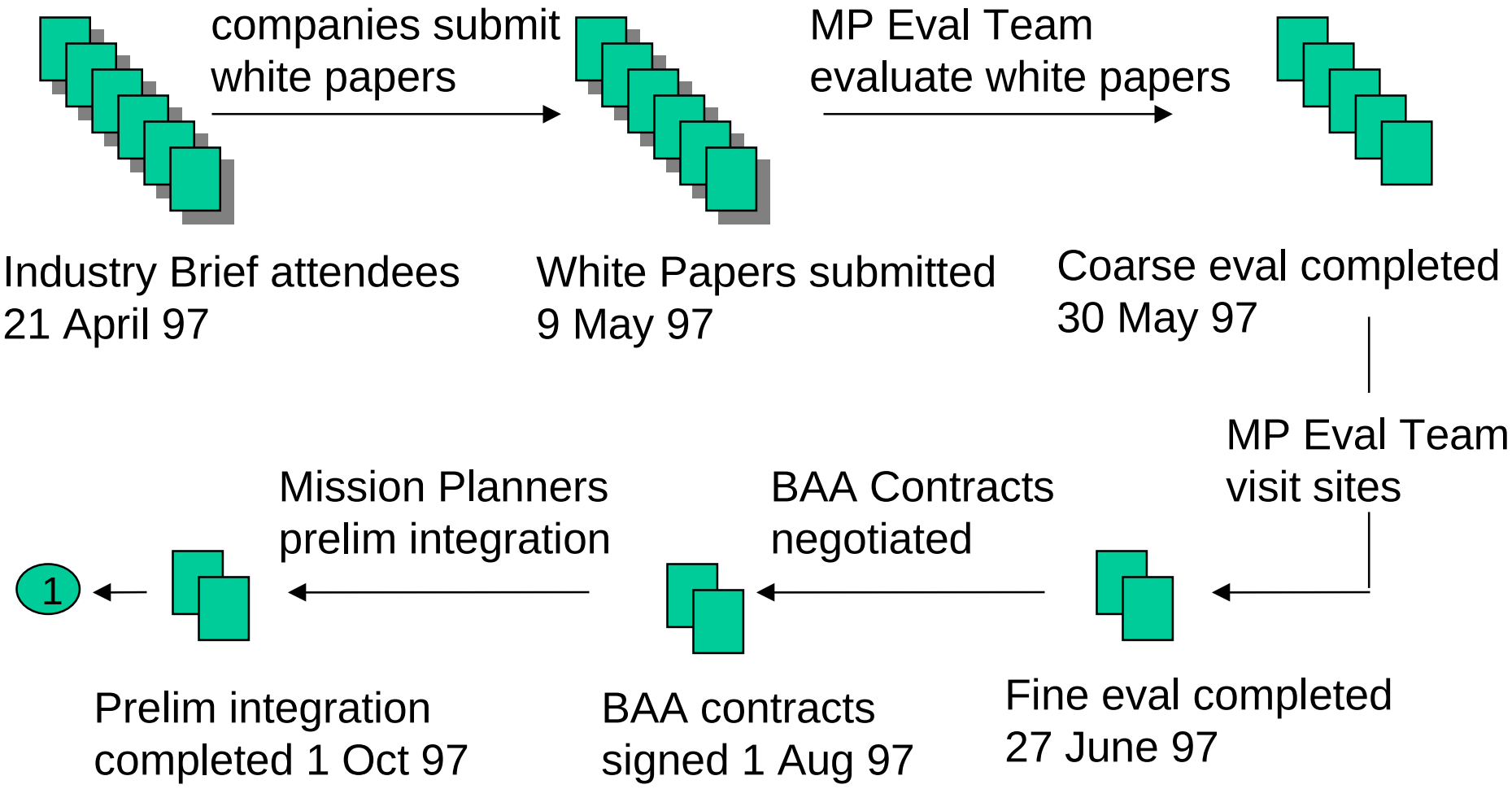
Evaluation Team

- Dori Sewell, Team Lead
- Darrell Bowman
- Steve Daniel
- Mike Fugate
- Roger Gray

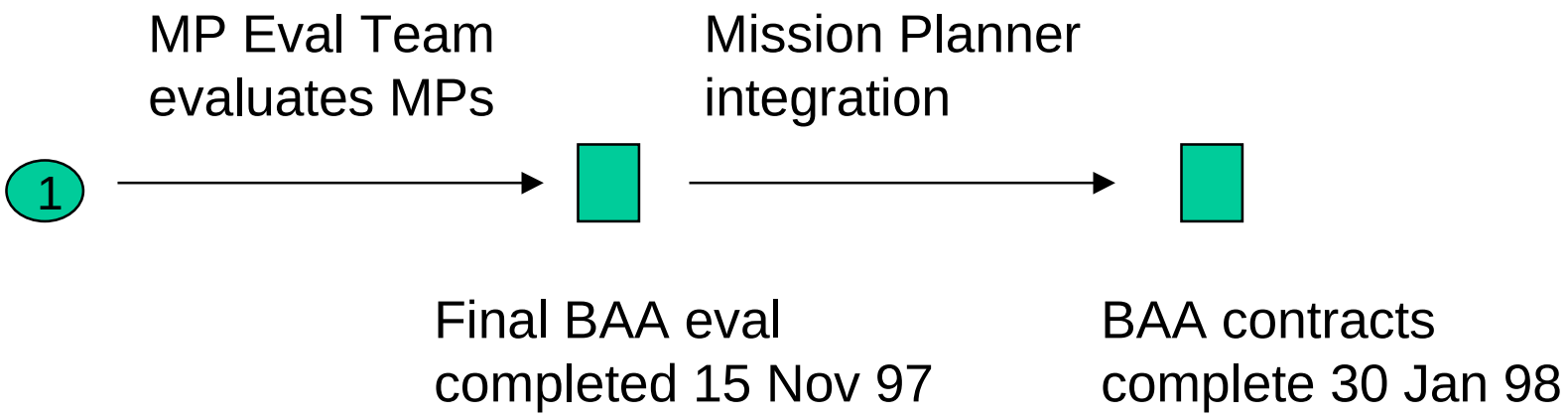
BAA / Evaluation Process Schedule Milestones

- BAA published -- 27 March 97 ☑
- Brief to Industry -- 21 April 97 ☑
- White Paper Submission -- 9 May 97
- Coarse Evaluation -- 30 May 97
- Fine Evaluation -- 27 June 97
- Contracts -- 1 August 97
- Integration -- 1 October 97
- Final Evaluation -- 15 November 97

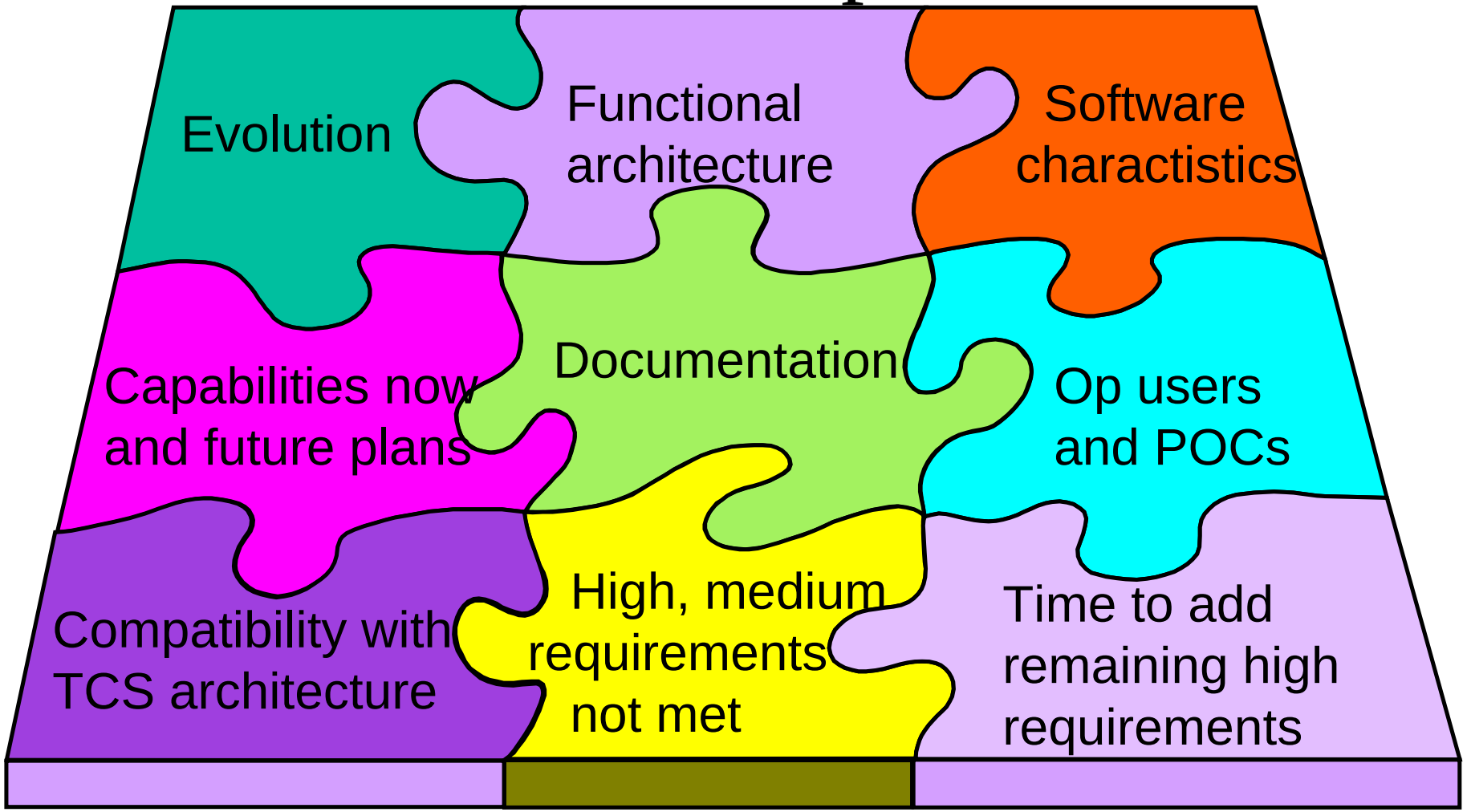
Mission Planner BAA Process



Mission Planner BAA Process (cont.)



White Papers



White Paper Outline

1.0 Description of Current System
- 1.1 Evolution of system
- 1.2 Functional architecture
- 1.3 Software characteristics
- 1.4 Current capabilities / future plans
- 1.5 Documentation available
- 1.6 Operational users (including POCs)

2.0 Compatibility with TCS needs
- 2.1 Minimum criteria
  - 2.1.1 Rights granted (unlimited; or what rights at what cost)
  - 2.1.2 Hardware/Operating System options
  - 2.1.3 Availability for demo
  - 2.1.4 Types of fixed wing aircraft/payload missions supported

White Paper Outline (cont.)

2.2 Additional Criteria

2.2.1 High Priority Criteria Not Met

2.2.2 Medium Priority Criteria Not Met

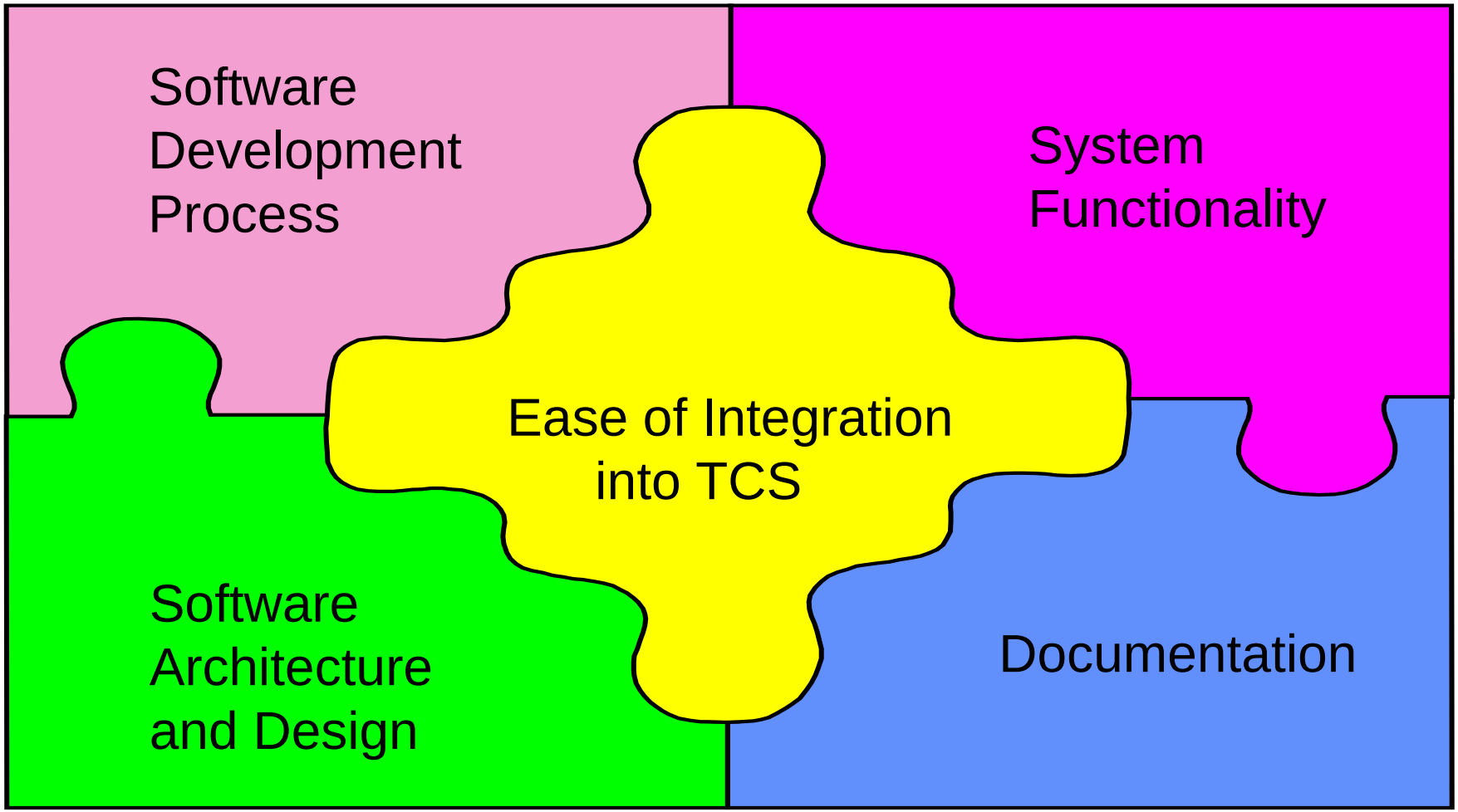
2.2.3 Effort to Add Remaining High Priority Functionality

2.3 Compatibility with TCS Architecture

Coarse Evaluation

- Based on white papers
- Prioritized criteria
  - Minimum criteria
    - pass/fail
    - must have perfect score
  - Additional criteria
    - high, medium, low priority
    - score range based on priority
- 5 systems selected for fine eval.

Fine Evaluation Purpose

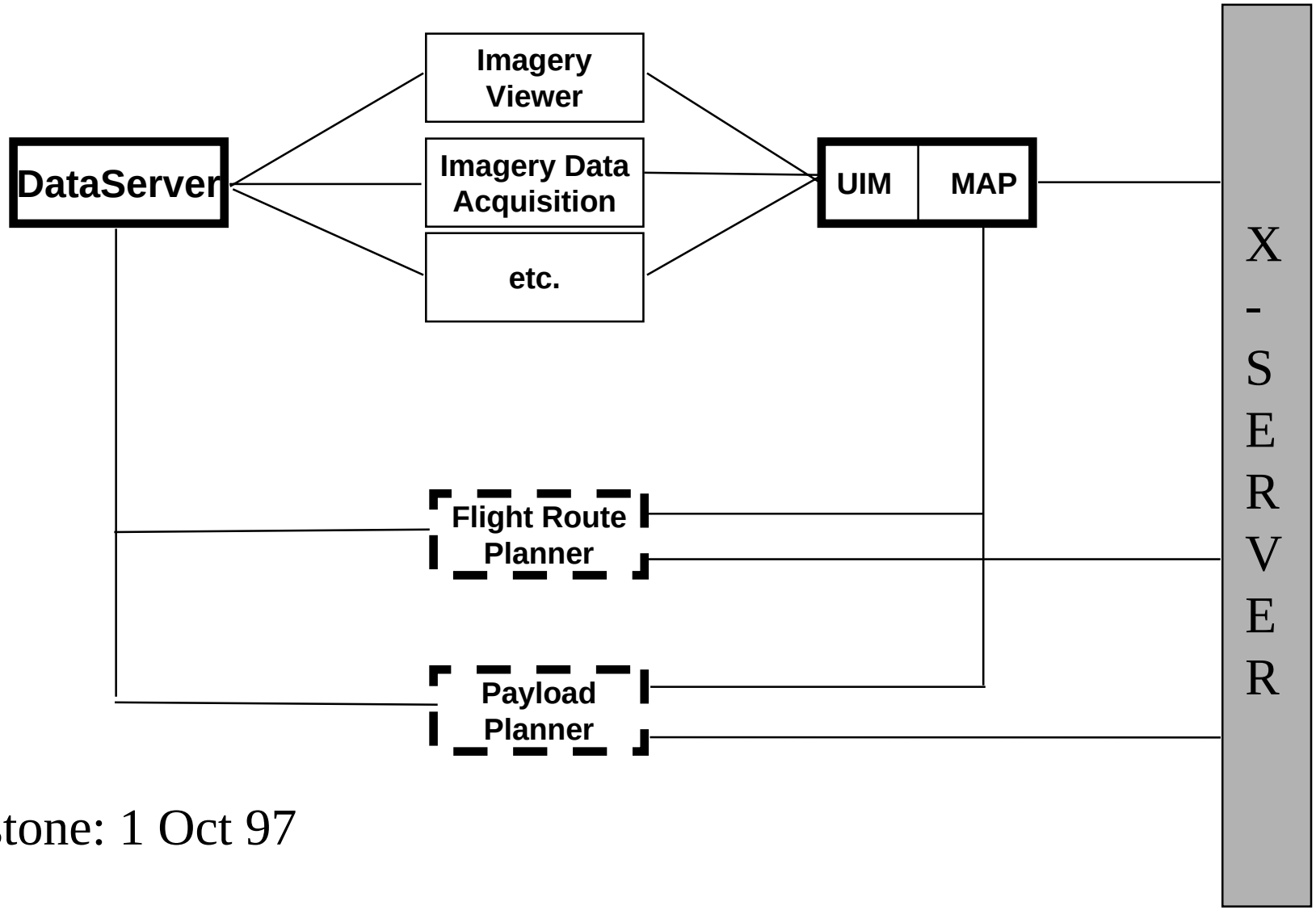


Fine Evaluation

- Fact-finding visit (2 days)
- Organization should provide plan, schedule and ROM cost to implement high and medium priority requirements
- Demo required
- Two systems selected for integration into TCS
- $600K over 6 months (per system)

TCS Integration Proposal - Example

Integrated to JMTK Map, Chart



Milestone: 1 Oct 97

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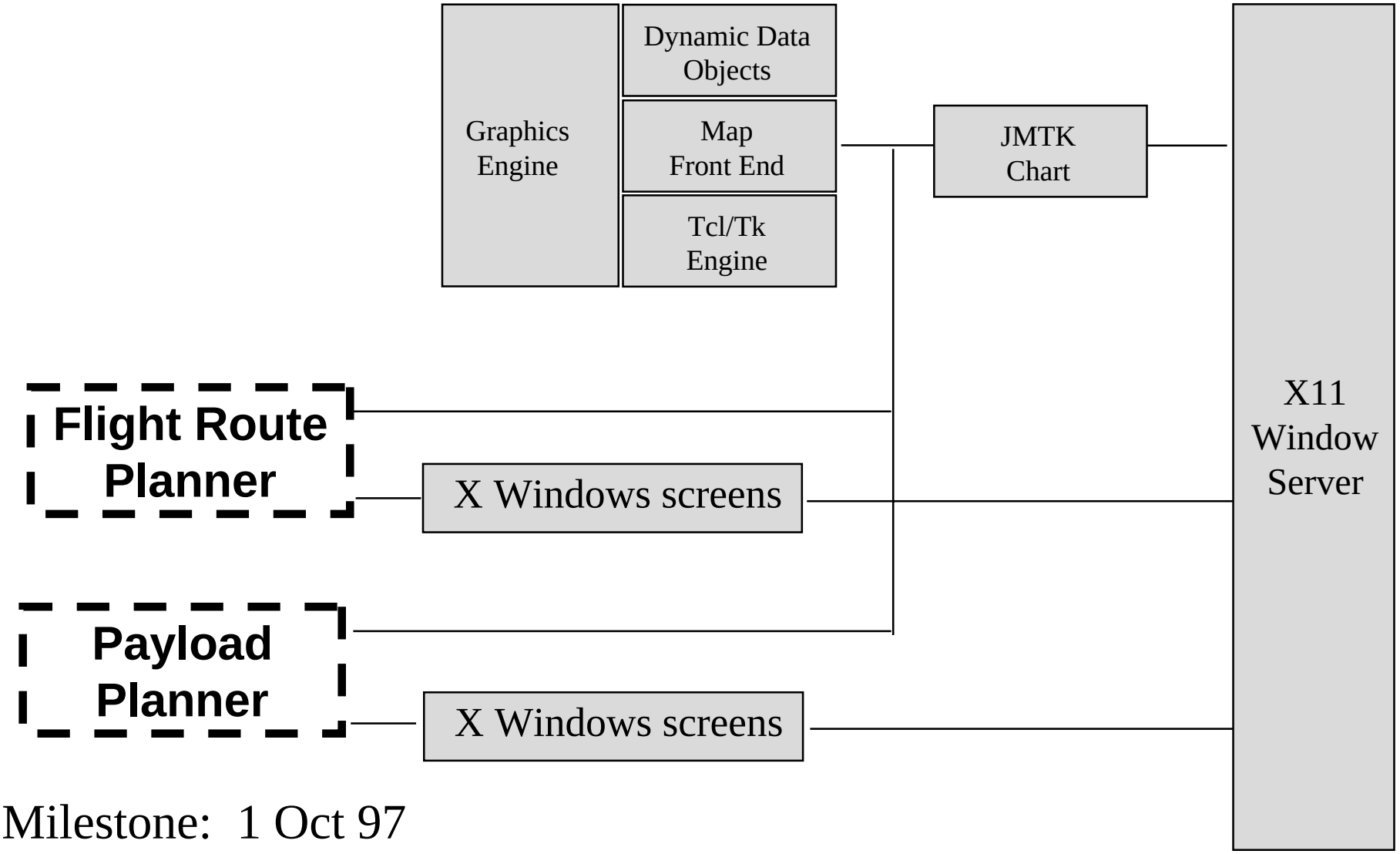
Integrated to JMTK Map, Chart

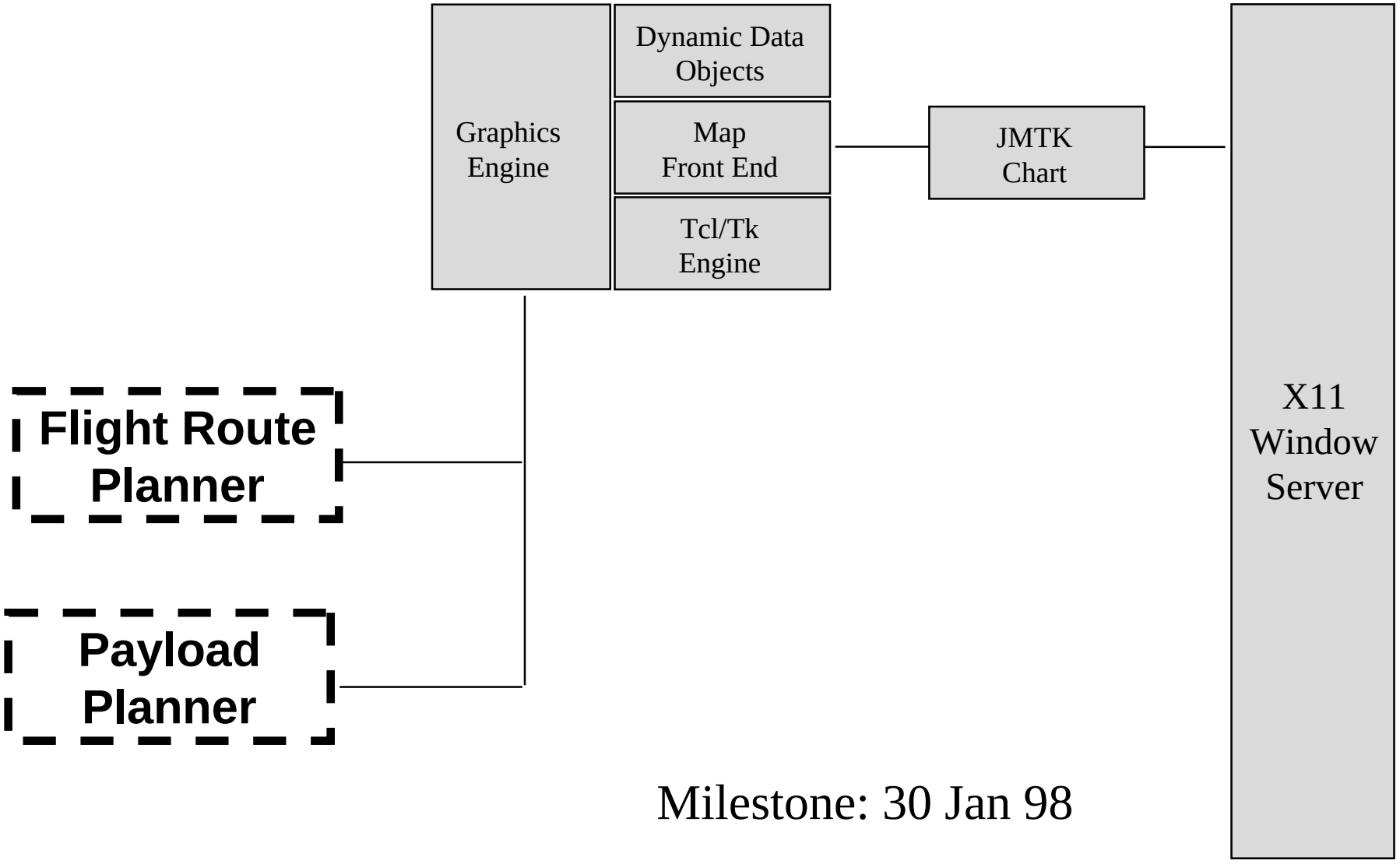


Milestone: 1 Oct 97

Final Evaluation

- After integration into TCS
- Evaluation includes
  - functional testing
  - user friendliness
  - military suitability
- One route planner and one payload planner selected for flight certification and support C2 for TCS Phase 1

TCS Integration Proposal - Example
(Long Term) Integrated to TCS's UIM/GE



Milestone: 30 Jan 98

Additional Information Available

- Contact Kitty Hall
  - (540) 653-7942
  - kbhall@nswc.navy.mil
- UAV TCS Home Page
  - http://uav.nswc.navy.mil/tcs
    - TCS Operational Requirements Document
    - TCS Concept of Operations
    - TCS Program Plan
    - TCS Overview Presentation